AN EVALUATION OF THE SUSTAINABILITY OF THE

NATIONAL FADAMA DEVELOPMENT PROJECT III IN BENUE STATE

BY

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BSU/SS/Ph.D/11/5914

A THESIS SUBMITTED TO POSTGRADUATE SCHOOL, BENUE STATE UNIVERSITY, MAKURDI, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) IN ECONOMICS

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DECLARATION

I hereby declare that this research work was written by me and that no part of this work has been presented before for the award of any degree. All borrowed ideas have been duly acknowledged.

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CERTIFICATION

We certify that this thesis titled **An Evaluation of the Sustainability of the National Fadama Development Project III in Benue State** has been duly presented by **Member Ahemen (BSU/SS/Ph.D/11/5914)** of the Department of Economics, Faculty of Social Sciences, Benue State University, Makurdi, and has been approved by the Examiners.

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Having met the stipulated requirements, the thesis has been accepted by the Postgraduate School.

Dean

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Date

DEDICATION

This thesis is dedicated to my:

Parents, Chief and Chief Mrs. Gwambe Dekera, for laying the foundation for this academic pursuit;

Foster parent, Adeede Ukpabi, for providing the springboard that lifted me higher; and

Family, Dr. Terzungwe Ahemen, Nguavese, Aondona, Sesugh and Terkuma, for making this dream a reality.

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Abstract

Government over the years have embarked on programmes and projects to boost agriculture in Nigeria, yet most of these projects fold up once funds are not forth coming from donor agencies. The Planner of Fadama III project incorporated sustainability in its component to ensure continuity. The thesis evaluated the sustainability of the National Fadama Development Project III in Benue State via assessing the projects' implementation, income, savings, efficiency of production and adoption of technology by Fadama III farmers. Data were collected during a survey through the use of a well-structured questionnaire administered to 556 Fadama III beneficiaries grouped into Fadama User Groups and Individual Crop Farmers. Logit regression analysis and the Stochastic Frontier analysis were used to analyze the data. The sustainability index was measured using the Sustainability Assessment of Farming and the Environment framework. The result indicated that even though Fadama III project was not fully implemented in Benue State, there was a significant increase in the average income of the beneficiaries from baseline income. Findings also show that average savings were below 10% for more than 70% of the beneficiaries. Estimates of the stochastic frontier production function analysis showed that Fadama III beneficiaries were not efficient in their productive activities. Finally, the sustainability index was below 50% for all beneficiaries, the indicators that contributed more to low sustainability were savings and economic efficiency. The study concluded that even though the Fadama III project was beneficial to most farmers in Benue State, it is not sustainable. It was recommended that there is need for Deposit Money Banks or Micro-finance Banks to be established in all the Local Government Areas and farmers encouraged to save. Also, the full implementation of project in subsequent Fadama project will go a long way in sustaining the gains of the Fadama project for Benue State and Nigeria at large.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Agriculture is the mainstay of the majority of people living in rural areas and they are confronted with extreme poverty and hunger especially in developing countries. Okyere and Jemaneh (2012) affirmed that about 65 per cent of the total labour force in Africa is employed in the agricultural sector, contributing about 32 per cent to the continent's Gross Domestic Product (GDP). Given that the agricultural sector is the largest employer of labour in developing countries; its growth has significant impact on poverty reduction. Diao, Thurlow, Benin and Fan (2012) observed that countries in Africa, south of the Sahara reached milestones in the 21st century's first decade with much improvement in macro-economic stability and sustained economic growth, yet the agricultural sector's growth which stood at 3.4 per cent per year over 2001-2010 lagged behind national economic growth in Africa. Given that most poor people are dependent on farming, the slow growth in agriculture is an obstacle to regional poverty reduction. Therefore, efforts to reduce poverty in Africa must pay particular attention to the agricultural sector.

In Nigeria, agriculture has been the most important economic sector since independence in terms of contribution to GDP and employment generation. A retrospective examination of the Nigerian economy and its development as described by Muhammed-Lawal and Atte (2006) reveals that agriculture was both the main stay of the Nigerian economy and the major foreign exchange earner. In the 1960s, agriculture accounted for well over 80 per cent of the export earnings and employment; about 65 per cent of the GDP and about 50 per cent of government revenue. This contribution to the Nigerian economic growth however declined over the years. The contribution of agriculture to the GDP fell from 50 per cent in 1970 to 34 per cent in 2003.

The National Bureau of Statistics (2012) reported that the agricultural sector accounted for only 40.9 per cent of the real sector. Although agriculture no longer serves as the leading contributor to Nigeria's Gross National Product, it is still the most dominant economic activity in terms of employment and linkages with the rest of the economy. Thus the decline in agriculture has caused rising poverty. Data from the National Bureau of Statistics (2012) shows that only 27.2 per cent of Nigerians were below the poverty line in 1980, the number increased to 54.4 per cent in 2004; this increased further to 69.0 per cent in 2010. In the 2010 figure, 73.2 per cent are from the rural areas. Adeolu and Alimi (2004) in their analysis of poverty trends in Nigeria noted that poor families are in higher proportion in farming households who are mainly in the rural areas.

This rising level of poverty in Nigeria is disheartening given the vast resources in the country. With her reserves of human and natural resources, Nigeria has the potential to build a prosperous economy and provide for the basic needs of her population. This enormous resource base, if well harnessed could support a vibrant agricultural sector capable of ensuring the supply of raw materials for the industrial sector, provide gainful employment for the teeming population and reduce poverty. It is therefore, imperative that any appropriate policy measure aimed at alleviating poverty in Nigeria must take agriculture and rural development seriously and focus on raising agricultural incomes.

Successive governments over the years have embarked on policies and programmes aimed at increasing agricultural productivity and alleviating the poverty scourge. These include the Farm Settlement Schemes launched in 1960; the National Accelerated Food Production Programme (NAFPP), launched in 1972; Agricultural Development Project (ADP) enclave, which started in 1975; Operation Feed the Nation, launched in 1976; the Federal Government's capital expenditure on Agriculture during the period of Operation Feed the Nation was ₦129.2 million in 1976, ₦113.7million in 1977, ₦125.0 million in 1978 and ₦98 million in 1979. The programme ended in 1979 (Ukoha, 2007). River Basin and Rural Development Authorities, established in 1976; Green Revolution Programme, inaugurated in 1980; Maduagu (2001) reported that when the Green revolution programme ended in 1983, ₦2 billion tax payers' money was expended on it. The Directorate of Food, Roads and Rural Infrastructure (DFRRI) was created in 1986; the project gulfed ₦1.9 billion and ended in 1993 (Maduagu 2001). National Agricultural Land Authority (NALDA) 1991-1999; Presidential Initiative on Cocoa, Cassava, Rice, Livestock, Fisheries and Vegetables (1999-2007).

Another effort towards boosting production and enhancing farmers' welfare was the introduction of the National Fadama Development Project (NFDP). The project was a development intervention to enhance food security with the overall purpose of reducing poverty among farmers. The first phase tagged Fadama I was implemented during the period 1993-1999; Olumese (2014) reported that funding for the project was US$67.5 million. Another phase tagged Fadama II started in 2005 with an estimated cost of UA22 million equivalent to US$31.67million loan from the African Development Bank, UA 52.97 million equivalent to US$76.25million from the International Development Agency of the World Bank and UA 5 million equivalent to US$ 7.2 million from the Global Environmental Fund grant (African Development Fund, 2003)

Following the success of Fadama II, the Federal Government requested a follow-on project since only a portion (18 States) of the poor were covered. The Fadama III project was launched to expand coverage and include the remaining 19 States. The total cost of the project was US$450.0M (World Bank, 2008). Fadama III's overall objective was to sustainably increase the incomes of Fadama users thus contributing to poverty reduction, improve food security and achieve the key objective of the Millennium Development Goal of eradicating extreme hunger and poverty. In Benue State, the Fadama III project covered twenty (20) Local Government

Areas and funded One hundred and fifty two (152) Fadama Community Associations. It also funded one thousand eight hundred and fifty seven (1857) Fadama User Groups across the state.

Since independence, the government has embarked on so many policies and programmes to boost agriculture and so much money has been spent on these programmes yet majority of these projects folded up once funds were not forth coming from the donor agencies. Due to the unsustainability of earlier programmes, planners of Fadama III project incorporated sustainability in its component to ensure continuity. The sustainability concept incorporated in the Fadama III project was to ensure that farmers adopt practices that will enable their farms and businesses survive. Current understanding maintains that agriculture is sustainable when current and future food demands can be met without necessarily compromising economic, ecological, and social needs. To boost the economic needs of farmers, sustainable agriculture stands for maximizing the productivity of the land, maximizing farm income and having optimum knowledge of the industry. Thus, the extent to which these economic needs have been met to achieve sustainability by Fadama III beneficiaries in Benue State is yet to be established. This research work therefore, has examined the sustainability of the National Fadama Development Project III in Benue State.

1.2 Statement of the Problem

The strategic location of Benue State between the Southern forest regions and the Northern Semi-arid grassland regions of the country makes it to have very fertile land for agriculture. With an estimated arable land constituting about 60 per cent of the total area, the State has two main rivers (Benue and Katsina- Ala) and the lower courses of their tributaries contribute to the recharge of aquifers, thus providing good source of water for irrigation farming. As a result of these immense agricultural potentials, about 80 per cent of the total population derives her livelihood from subsistence agriculture (Benue Agricultural and Rural Development Authority, 1998).

Despite the immense agricultural resources in Benue State, and the involvement of majority of her indigenes in agriculture, there has not been a corresponding reduction in poverty and unemployment. The National Bureau of Statistics (2012) estimated that 67.1 per cent of Benue people were absolutely poor, with an unemployment level of 25.4 per cent. To boost agriculture in the State, the Fadama III project was inaugurated in 2009 to increase incomes and reduce poverty. To enhance economic sustainability of the project, Fadama III farmers were to adopt new technologies introduced through extension/advisory services, produce efficiently and maximize income and savings as indicators of sustainability so as to guarantee the continuity of the project. Given that the project ended in 2013, the concern is that, to what extent had the beneficiaries of Fadama III achieved sustainability in their operations?

Studies have been conducted on the Fadama project in Benue State such as Fadama Land-Efficiency, Income and Quality of Life Improvement under the World Bank Intervention in Benue State conducted by Ater and Umeh in 2011. Another study by Agbarevo and Age (2013) examined the Effect of the Third National Fadama Development Project on the Income of Farmers in Kwande Local Government Area of Benue State. Several other studies have been carried out to assess the different components of the Fadama III project in Benue State at mid-term (Abu, 2011b; Shimayohol, 2011; Ojowu, 2011; Umeh, 2011). However, to the best of this review, none of these studies have decisively dealt with the issue of sustainability of the Fadama III project in Benue State. Not much has been done to show whether or not, Fadama III beneficiaries have been sustainable in their productive activities. The areas that were examined to achieve sustainability are provision of counterpart funds, income, savings and adoption of improved technology by Fadama III beneficiaries. This research work has filled the gap by examining the sustainability of Fadama III project in Benue State.

1.3 Research Questions

The following research questions were raised:

i. What are the socio-economic characteristics of Fadama III beneficiaries in Benue State?

ii. How has the Fadama III project been implemented across its various components in Benue State?

iii. What are the differences if any, in the incomes of Fadama III beneficiaries in Benue State from the baseline income?

iv. How sustainable are the savings of Fadama III beneficiaries in Benue State?

v. What socio-economic factors influence the adoption of new technology by Fadama III beneficiaries in Benue State?

vi. How are the Fadama III beneficiaries in Benue State efficient in their productive activities?

vii. To what extent are the productive activities of Fadama III project beneficiaries sustainable?

1.4 Objectives of the Study

The main objective of this study is to evaluate the sustainability of the National Fadama Development Project III in Benue State. Specifically, the study seeks to:

i. analyze the socio-economic characteristics of Fadama III beneficiaries in Benue State;

ii. assess the implementation of the Fadama III project across the various components in Benue State;

iii. examine whether or not there are differences in the incomes of beneficiaries of the Fadama III project in Benue State from the baseline income;

iv. assess whether or not the savings made by beneficiaries of Fadama III project in Benue State are sustainable;

v. investigate the socio-economic factors that influence the adoption of new technology by Fadama III beneficiaries in Benue State;

vi. examine the level of efficiency of production by Fadama III beneficiaries in Benue State; and

vii. assess the extent of sustainability of productive activities of Fadama III project in Benue State

1.5 Research Hypotheses

The following hypotheses were stated:

i. $Ho_{1:}$ Fadama III project is not fully implemented across the various components in Benue State.

ii. Ho_2 There are no differences in the incomes of Fadama III beneficiaries from baseline income.

iii. $Ho_{3:}$ Savings made by Fadama III beneficiaries in Benue State are not sustainable.

iv. $Ho_{4:}$ Socio-economic factors have no probability of influencing the adoption of technology by Fadama III beneficiaries in Benue State.

v. $Ho_{5:}$ Fadama III beneficiaries in Benue State are not efficient in their productive activities

vi. $Ho_{6:}$ Productive activities of Fadama III beneficiaries in Benue State are not sustainable.

1.6 Scope of the Study

The study covered the Fadama III project in Benue State from 2009 to 2014. The period was chosen because Fadama III started in Benue State in 2009, and data on economic activities of the beneficiaries of Fadama III project in Benue State used for the study was the 2014 farming season. The work specifically covered the Fadama III project in Logo, Buruku and Otukpo Local Government Areas representing Zones A (Benue North-east), B (Benue North-west) and C (Benue South) respectively. The study focused on the Fadama User Groups (FUGs)/Economic Interest Groups (EIGs) and individual farming households that benefited from the Fadama III project in Benue State. The major productive sectors of the EIGs are crops, livestock, fish farming, and agro processing enterprises and the crops covered by the study are cassava, yam, groundnut and rice. The components studied are; component one (1) capacity building and, communication and input support, component two (2) small-scale community-owned infrastructure, component three (3) advisory services and input support, component four (4) support to the Agricultural Development Projects (ADPs) and sponsored research and component five (5) asset acquisition for individual Fadama User Groups. The study focused on the economic aspect of sustainability, analyzing variables such as farm income, non-farm income, farm size, savings, technical and economic efficiency, farming experience, extension contacts and adoption of technology.

1.7 Significance of the Study

Agriculture remains the corner stone of many economies especially in sub-Saharan Africa where food crises exist and majority of the people are poor. In Nigeria, the importance of agriculture as the sector with the most important economic activity, employing more than 80 per cent of Nigerians, most especially those in the rural sector, cannot be over-emphasized. The decline in agriculture as the major sector contributing to GDP which is a result of low agricultural productivity has led to a fall in food sufficiency for Nigeria's teaming population. This has resulted in the huge importation of food. The country spends about 1.3 trillion naira yearly importing staple food that can be produced locally; this displaces local production creating unemployment and poverty (Shittu, 2013). Therefore this work provides insights into how the agricultural sector can be revamped to take its rightful position of food production, employment generation and poverty reduction.

An additional significance of the work is in line with the renewed interest by government to revamp the agricultural sector following the drastic fall in oil price. Information from the research work is expected to guide policy makers in allocating public resources in areas where productivity in the sector will be boosted. In addition, unlike the work, existing literature on Fadama III in Nigeria and Benue State in particular tend to concentrate on income of Fadama III farmers to the neglect of other issues like savings and adoption of technology. Furthermore, existing literature tend to dwell more on crop production neglecting other aspect like livestock, agro-processing and fisheries. Policy design to improve agricultural productivity and sustainability of Fadama III project will have limited effect if these aspects of agriculture are not examined. Futhermore, this research work shall contribute to theory in the sense that it will provide sustainability indices as reference values which will make room for comparism of an indicator value for subsequent sustainability assessment.

The current emphasis on sustainable development by the United Nations which brought about the Sustainability Development Goals (SDGs) makes a research work on sustainability of Fadama III project apt to current development. Consequently this research work shall provide sustainability indices that will provide Fadama III farmers with a tool to measure their achievements toward sustainability. Also these indices shall provide comparisons between

Economic Interest Groups in the economic aspects of their production. On the whole, the indices are expected to inform policy makers about the current state and subsequent trends in farm performance and encourage public participation in sustainability discussions.

Finally, this research work is expected to serve as an additional reference material for future research and is expected to be useful to all stakeholders in the agricultural sector, the government, donor agencies, farmers and extension service providers.

1.8 Organization of the Study

The general framework of the research is made up of five (5) chapters. Chapter one, the introductory chapter covered the background to the study, problem statement, objectives of the study and the research hypothesis. In addition, the scope and significance of the work were presented in this chapter. Chapter two presents the review of the relevant literature. The conceptual and theoretical frameworks as well as the empirical literature were reviewed in this chapter. Chapter three centered on the methodology. The chapter presented the sources of data as well as the sampling techniques and the analytical tools. Data and results were presented and analyzed in Chapter four, while Chapter five summarized the research, providing conclusion and recommendations.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Conceptual Framework

2.1.1. The Concept of Fadama

Fadama is a Hausa name for irrigable land. These are flood plains and low-lying areas underlined by shallow aquifers and found along Nigeria's river systems (Ingawa, Oredipe, Idefor and Okafor, 2004). Fadama also refers to a seasonally flooded area used for farming during the dry season. It is defined by Qureshi (1989) as alluvial, lowland formed by erosion and depositional actions of the rivers and streams. Fadama are typically waterlogged during the rainy season but retain moisture during the dry season, these low-lying flood planes have easily accessible shallow ground water. Since these land resources are also potentially irrigable, they are vastly suitable for crop production, fishing as well as provision of water and feed for livestock. The areas are considered to have high potential for economic development through appropriate investments in infrastructure and household assets. Fadama land resources are largely wet during much of the year. They encompass land and water resources that could easily be developed for irrigation agriculture (World Bank, 1994).

The development of the Fadama project came from the realization that supplementary dry season irrigation farming is essential to meet the food need of the growing Nigerian population. The National Fadama Development Project (NFDP), a World Bank assisted project was established to ensure all year round production of crops through the exploitation of shallow aquifers and surface water potentials using tube well, wash bore and petrol-driven pumps technology (World Bank, 1992). The project has undergone three phases; Fadama I, II and III since inception in

1993 and has been adjudged successful (ADF 2003, Nkonya *et al.* 2008, Nwachukwu, Agwu, Ezeh, Mbanasor, Onyenweaku and Kamalu 2008, Umeh 2011, Agbaravo and Age 2013).

2.1.1.1 Fadama I

The first Fadama project, termed Fadama I, was implemented between 1993 and 1999 in 25 states; Bauchi, Jigawa, Kano, Kebbi, Sokoto, Kogi, Niger, Plateau, Benue, Taraba and Ogun. Others were Oyo, Osun, Ondo, Lagos, Edo, Delta, Anambra, Enugu, Imo, Abia, Rivers, Cross River, Akwa Ibom and the Federal Capital Territory. Fadama I focused mainly on crop production, and farmers adopted the use of simple, low-cost improved irrigation technologies comprising motorized pumps and tube wells, which resulted to increased incomes and general improvement in social and economic well being of participating communities.

Fadama I also had its short comings. It largely neglected downstream activities such as processing, preservation and conservation and rural infrastructure to ensure the efficient evacuation of farm output to markets. Furthermore, the project did not take into consideration other resource uses such as those for livestock and fisheries production. This resulted not only in increased conflict between the users of the Fadama resources, but also restricted benefits to only those accruing from crop production (ADF, 2003). Nwachukwu *et al.* (2008) observed that Fadama I project did not involve key stakeholders such as producer organizations, local government organizations, the private sector and civil society organizations in designing and implementing projects. Also, they observed that Fadama I did not address mechanisms for conflict resolution in the Fadama project areas and gave little support to the establishment of rural non-farm enterprises. In order to address these shortfalls, the second phase of the project, Fadama II was set up in 2004.

2.1.1.2 Fadama II

Following the completion of Fadama I project, the government of Nigeria adopted a follow-up project termed Fadama II to address the constraints of the first Fadama project and to replicate the successes of the Fadama I project in other parts of the country. The project was co-financed with loans from the African Development Bank to cover the programme in six States; Borno, Jigawa, Katsina, Kogi, Kwara and Plateau, and International Development Agency of the World Bank to cover 12 States; Adamawa, Bauchi, Gombe, Niger, Imo, Kaduna, Kebbi, Lagos, Ogun, Oyo, Taraba and the Federal Capital Territory. A grant from the Global Environmental Fund was used to address environmental issues in all the 18 States participating in Fadama II (ADF, 2003). The project took off in 2005 and its development objective was to sustainably increase the incomes of fadama users through empowering communities to take charge of their own development agenda, and by reducing conflict between fadama users. The project tried to address the shortcomings of Fadama I by shifting from a top-down and a supply-driven public sector development programme to a Community-Driven Development (CDD) approach. Fadama II also included other Fadama resource users that the first programme had ignored. Nkonya *et al*. (2008) maintained that the design of the Fadama II project met all the key features of a CDD project. Consistent with the CDD approach, the project activities were centered on Fadama User Groups (FUGs) and Fadama Community Associations (FCAs).

As part of its targeting strategies, Fadama II provided special preferences to groups of youth, women (especially widows), physically challenged persons, the elderly, and people with HIV/AIDS. Targeted groups could belong to any of the productive or service sectors supported by the project. Using the CDD approach, beneficiaries were given the chance to choose the kind of activities they wanted to pursue. However, there were some activities that the project did not support, such as activities that could lead to degradation of natural resources (National Fadama

Development Office, 2005). Through the CDD approach, communities would decide on the advisory services and infrastructure they need to enable them develop goals they set for themselves based on their own efforts; the consensus reached would be articulated in Local Development Plans. The project targeted the resource poor rural farmer with an aim of raising agricultural productivity and reducing poverty. Its actual implementation began in September 2005.

2.1.1.3 Fadama III

To replicate the success of the Fadama II project and provide a wider access to the poor, the Third National Fadama Development Project (Fadama III) was established. The credit for the project was obtained from the International Development Association (IDA), the Federal, State and Local Governments. The communities, including the private sector and civil society also contributed (World Bank, 2008).The Project Development Objective (PDO) of Fadama III was to increase incomes of users of rural land and water resources on a sustainable basis. The key indicators and targets of the PDO, according to World Bank (2008), were:

i. Income of participating households: 75 per cent of Fadama user households, who benefit directly from project-supported activities, were expected to increase their average real incomes by at least 40 per cent by 2013.
ii. Yields of primary agricultural products of participating households: 20 percent increase in yield of primary agricultural products of participating households.
iii. Savings of participating groups: 10 percent of net earnings from income-generating activities of the FUGs are saved annually (with effect from year two).
iv. Physical verification of operations, maintenance and utilization of assets at mid-term and at project closing by surveys of randomly selected sites.

v. Surveys at mid-term and at project closing to show that at least 75 percent of Fadama users are satisfied with operations, maintenance and utilization of community owned infrastructure and capital assets acquired through the project.

The Fadama III project was designed to support the financing and implementation of six components. These were designed to transfer financial and technical resources to the benefiting groups. The main components of the project as reported by the World Bank (2008) were:

Component 1: Capacity building, communications and information support.

This component was to provide capacity building support for community organizations to mobilize beneficiaries into viable FUGs. It was also to provide capacity, communications and information support. The capacity building sub-component was key to the successful implementation of the project and consequently for realizing the benefits from the subprojects funded by the project. Although, the benefits of this sub-component were largely indirect, they were entangled and embodied in the utilization of infrastructure or assets applied in the primary occupations (enterprises). The support was to include what was needed for the establishment and operation of the Fadama User Equity Funds. In this study, based on the set objectives, emphasis was placed on social capital formation and implementation of approved projects in local communities.

Component 2: Small-scale Community-owned Infrastructure.

This component was to support the allocation of grant resources annually to each of the participating FCAs for implementing priority demand driven community owned projects ranging in value from $1,000 to $10,000 equivalent to ₦150,000 to ₦1,500,000. These included projects rehabilitation and/or construction of feeder and access roads, culverts and small bridges, rural markets and infrastructure for sustainable natural resource management. It also included improved conservation of soils and agronomic practices, water harvesting techniques, and, where feasible, integration of this infrastructure into local/community land-use planning supported under Component 1. Funding principles were to be 90 percent grants and up to 10 percent of the investment costs as counterpart contributions (in cash or materials and labour) from the FCAs. In this study, this component was evaluated based on the implements available in the study area, especially the productive asset and equipment.

Component 3: Advisory services and Input Support.

This component was to support the delivery of advisory services responsive to the needs of Fadama users in production, processing, marketing and supply chain management and input support, including training to promote savings schemes within FUGs and to develop linkages between farmers' organization and financial institutions. The Project was also to provide support to empower Fadama users- farmers, pastoralists and other EIGs working within their organizations and through their Local Government Areas, to purchase advisory services from both public and private sources. Furthermore, matching grant arrangements were made to provide input support to beneficiaries. This facility shared the risk involved in the adoption of a new technology by the farmers to enhance their financial capacity to purchase farm inputs and to build savings from incremental earnings to finance future purchases. Farmers could receive a grant equivalent to 50 per cent of the purchase price of the input per FUG, with the remaining 50 per cent as the FUG-beneficiary-counterpart contribution. In order to ensure sustainability of the production process after the second season, the beneficiaries were to be assisted to link with financial institutions through capacity building support to open savings accounts and to access credit for future purchase of inputs. In this study, emphasis was placed on the beneficiaries' access to rural advisory services and inputs. Also, the beneficiarie's access to grant resources for purchase of agricultural inputs was analyzed.

Component 4: Support to the Agricultural Development Projects (ADP) and Sponsored Research

The Project was to provide support to the ADPs to provide specialized technical assistance and training to advisory service providers with emphasis on improving the quality, effectiveness, availability, affordability and timeliness of advisory services. The ADPs were to provide Training of Facilitators and Extension Staff and to organize Sponsored Research and On-farm Demonstrations. All these services are meant to encourage beneficiaries adopt new and improved technology. Thus, in this study the improved technologies adopted by beneficiaries were assessed and the factors affecting the adoption of improved technology were also evaluated.

Component 5: Asset Acquisition for Individual FUGs/EIGs.

For economically active FUGs, who constituted the majority of beneficiaries, the Project was to contribute up to 70 per cent of the total cost of the demanded subproject, while the beneficiaries made up-front cash payment of up to 30 per cent of the subproject cost. The cash counterpart payments were to be deposited in an approved commercial bank/financial institution. In addition, it was recommended that these FUGs establish savings scheme in order to promote community-level capitalization as well as to ensure sustainability of the investment activities funded through this Component. The savings will be in the form of withholding of an amount equivalent to at least 10 per cent of the net revenues of the FUGs annually. The FUGs savings scheme stipulated by Fadama III is largely to promote community–level re-capitalization as well as to ensure sustainability of the investment activities that are funded. The savings in the form of withholding of an amount equivalent to at least 10 per cent of the net revenue of the FUGs annually are essentially for re-capitalization. These arrangements were not only for replacement of the durable asset but also to maintain a high functionality of the asset before the end of the economic life (Umeh, 2011). The vulnerable groups were to receive a matching grant of up to 85 per cent of the total cost of the demanded subproject cost. They were to pay 15 per cent counterpart after harvest and/or the sale of their marketable surplus. All these support were meant to add value to agricultural commodities and that can be obtained in terms of the ability of the beneficiaries to process primary products. In this study, the income gained as a result of value addition to agricultural commodities processed was analyzed to determine if beneficiaries were able to reach the target set at 20% increase in income from sale of value added agricultural products.

2.1.1.4 The Concept of Fadama User Group (FUG)/Economic Interest Group (EIG)

Fadama User Group (FUG) comprises Fadama users with a common economic interest and is a type of economic interest group. These groups are formed within communities and they have an average of fifteen (15) members also referred to as households (Benue State Fadama Coordinating Office, 2013). The major productive activities of these FUGs, supported by the Fadama project include crops, livestock, fishing and fish farming, agro-processing enterprises and rural marketing service providers. Fifteen (15) of such FUGs form a larger association known as the Fadama Community Associations (FCAs). Another set of beneficiaries are the disadvantaged group; these are widows, the handicapped, the sick, people living with HIV/AIDs and the unemployed youths; these are also known as the vulnerable groups. Given that the FUGs are Fadama users with common economic interest, they are also called Economic Interest Groups (EIGs). Therefore in this study, the terms Fadama User Group (FUG) and Economic Interest Group (EIG) are used interchangeably to mean Fadama users with a common interest that form an association.

2.1.2 The Concept of Sustainability

Like most concepts, there is no universally accepted definition of sustainability. Webster (1997) argued that sustainability is a ‘social construct’ yet to be made operational. Sustainability is an integrative concept which considers environmental, social, and economic aspects as three fundamental dimensions. These three dimensions have been denoted as pillars of sustainability, which reflect that responsible development requires consideration of natural, human, and economic capital (Hansmann, Mieg and Frischknecht, 2012). This concept came into limelight after the Brundtland Commission's report. The report defined sustainable development as development which meets the needs of current generations without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). The concept supports strong economic and social development, particularly for people with a low standard of living. At the same time it underlines the importance of protecting the natural resource base and the environment. Barlund, (2004) affirmed that economic and social well-being cannot be improved with measures that destroy the environment. Inter-generational solidarity is also crucial; therefore all development has to take into account its impact on the opportunities for future generations.

Since the release of the Brundtland report, the concept and definitions of sustainability have expanded to include sustainable livelihoods, where people are the focus of development goals rather than resources or the government (International Fund for Agricultural Development, 2011). Sustainable livelihoods approaches are often used to understand relationships between factors affecting the livelihoods of poor people, and tend to focus on the priorities of farmers, their access to social, human, physical, financial, and natural capital, and the context in which they live (Institute of Development Studies, 2012). In this study, sustainability means to prolong the gains that accrue from empowering poor and marginalized households through projects, and ensure that the benefits realized continue even after the end of the project. Given that the Fadama project is biased in the agricultural sector, the assessment of sustainability of the

National Fadama Development Project III in Benue State is better explained in the context of agricultural sustainability, and a review of agricultural sustainability becomes necessary.

2.1.2.1 Sustainable Agriculture

Defining sustainable agriculture is a daunting task (Onyeiwu, Pallant, and Hanlon, 2011). Thus, Pretty (1999) defined sustainable agriculture as a concept that stands for maximizing the productivity of the land and improving the well-being of people under the constraint of minimal damage to natural resources. Tisdell (1996) focused on the maintenance or sustainability of agricultural product (or yields) as an indicator of sustainable agriculture. One common thread in the conventional definition of agricultural sustainability is the notion that sustainable agriculture is a system that makes the best use of nature's goods and services whilst not damaging the environment (Altieri, 1995). In other words, sustainable agriculture enhances the productive values of natural, social and human capital.

In spite of common concern about sustainable agriculture, there are differences among scholars on the attributes of sustainable agriculture. Some scholars consider low use of external inputs as a major requirement for agricultural sustainability (Schaller, 1993; Pretty, 1995). Other scholars such as Hansen (1996) and Webster (1997) with much interest in enhancing production find it necessary to increase the use of external inputs to some extent so as to maintain soil nutrient level and crop yield. There are still other scholars concerned much about ecological sustainability who emphasize maintaining agro-ecological health, biodiversity, landscape quality and integrated nutrient management as necessary conditions for agricultural sustainability (Conway, 1990; Clementsen & van Larr, 2000). In the same vein, Lampkin (1994) and Henning, Baker, and Thompsion (1991) find organic agriculture synonymous with sustainable agriculture, as it has no adverse impact on ecological health. There are still other scholars such as Tisdell

(1996); Smith and McDonald (1998) who are concerned mainly about the economic aspect of agricultural sustainability.

Hansen (1996) however maintained that interpretations of agricultural sustainability in high-income countries are often focused on ecological consequences of increased food production, as these countries often have food surpluses. In low-income countries battling poverty and hunger, and which experience frequent food shortages, concerns regarding sustainability are focused more on increasing productivity to meet the more immediate need to alleviate hunger and poverty. It is therefore recognized that sustainability should be interpreted with regard to economic and social needs.

This study adopts the definition by Hansen (1996), that sustainability in agriculture in less developed countries should be focused more on increasing productivity to improve incomes and enhance the economic and social needs so as to reduce hunger and poverty. Therefore in this study, sustainability in agriculture is the ability of the Fadama farmers to survive through adoption of technology and acquisition of assets to increase productivity, improve incomes and promote savings so as to improve on their economic and social wellbeing.

2.1.2.2 Measurement of Sustainability

Just as there are many different definitions of sustainability, there are also many differing viewpoints on appropriate ways to measure and assess sustainability. Part of the controversy surrounding sustainability assessments lies in the attempt of these assessments to measure multi-dimensional, dynamic, and complex systems with multiple levels of organization using only a few, easily measured indicators of sustainability. Bossel (2001) observed that sustainability as a concept has to be translated into the practical dimensions of the real world to make it operational.

Von Wire´n-Lehr (2001) identified two frameworks for selecting indicators of sustainability: content and system based frameworks. System-based frameworks are frameworks that use holistic system approach with integrated evaluation of the social, environmental and economic aspect of the system. They are based on the general attribute of the system such as growth, resilience and stability. On the other hand, content-based frameworks provide specific indicators that characterize single part of the system of concern. These frameworks facilitate the translation of functions into specific objectives and quantitative parameters such as farm income, non farm income and access to market.

In this study, a content based framework, the sustainability assessment of farming and the environment (SAFE) framework developed by Van Cauwenbergh *et al.*, (2006) was used to measure the sustainability of the Fadama III interventions. Also, only the economic indicators of sustainability were developed to measure the level of sustainability of Fadama III farmers in Benue State. The economic indicators developed for the EIGs were, annual income, farm size, savings, technical efficiency, economic efficiency, number of advisory services extended and extent of adoption of technology. The economic indicators developed for the individual crop farmers were, annual income, non-farm income, farmsize, savings, technical efficiency, economic efficiency, farming experience, number of advisory services attended and extent of adoption of technology. The benefit of this type of framework is that it is easier to determine specific objectives and quantifiable parameters and allows for evaluation of specific components; however, this type of framework does not provide an evaluation of the whole system.

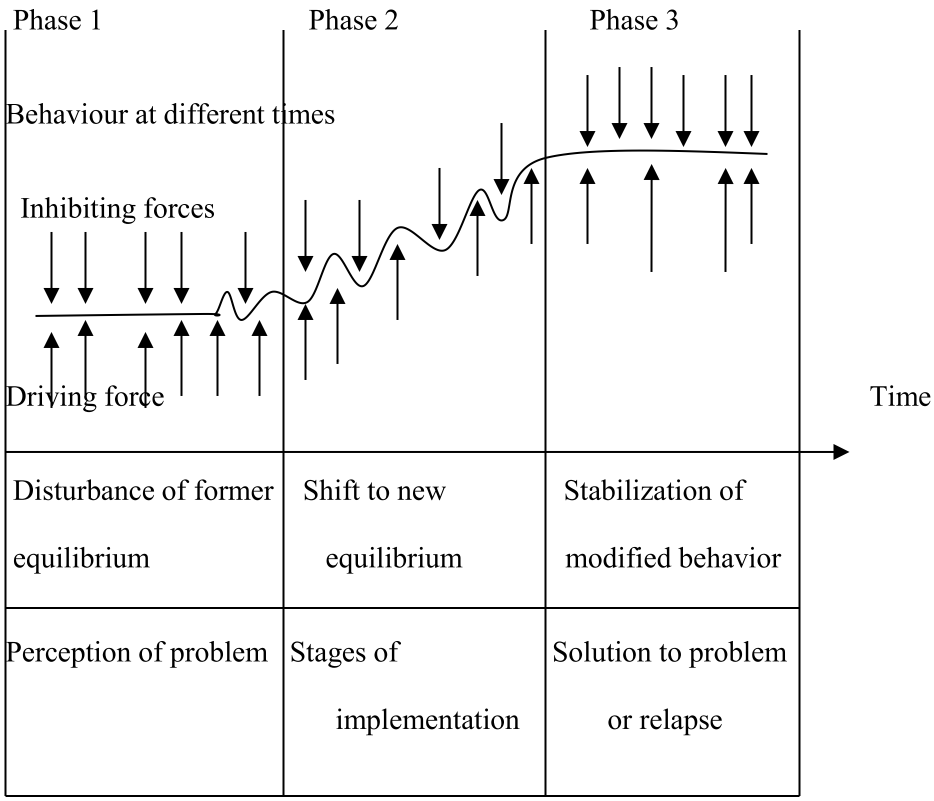
2.2 Theoretical Framework

2.2.1 The Endogenous Growth Theory

The most basic proposition of growth theory is that in order to sustain a positive growth rate of output per capita in the long run, there must be continual advances in technological knowledge in the form of new goods, new markets, or new processes. The neoclassical growth model developed by Solow (1957) and Swan (1956), shows that if there were no technological progress, then the effects of diminishing returns would eventually cause economic growth to cease. A crucial property of the aggregate production function is that there are diminishing returns to the accumulation of capital. If you continue to equip people with more and more of the same capital goods without inventing new uses for the capital, then a point will be reached eventually where the extra capital goods become redundant. It becomes necessary to place importance to the production or introduction of new technology which is the engine of growth through a constant return to scale of the production function.

2.2.2 Adoption Behaviour Model

Adoption is the acceptance of an idea or innovation and the willingness or intention to put it into practice, (Adams, 1982). According to Morris and Adelman (1988), there is no single theory of causation that can explain the traditional attitude of smallholder farmers in developing countries. However this study adopts the theory of behaviour modification developed by Ndah, Schuler, Uthes and Zander, (2010). The theory identified two forces influencing behavioural change; inhibiting forces and driving forces. A graphical representation of the theory is presented in Figure 1.



Source: Ndah *et al*., (2010)

Figure 1: Theory of Behaviour modification

The figure shows that there are inhibiting forces negatively influencing behavioural change such as lack of subsidies, limited liquidity (for labour hiring, buying herbicide, and seeds amongst others), lack of machinery and limited knowledge. Figure 1 also shows driving forces-forces conducive to positive target (adoption) such as technical advice, training, provision of inputs, financial assistance, and linkage with market outlets amongst others.

Behaviour (adoption) is thus seen as resulting from the psychological fields of inhibiting and driving forces, hence these forces are present in a state of equilibrium or dis-equilibrium with varying degrees of tension between them. Once such forces are identified in the farmers decision making process, the chances of diffusion can be estimated and consequences for promoting programmes can be concluded (Ndah *et al.* 2010).

The application of the theory of behavioural modification to Benue State Fadama III farmers is that, at the first stage of perception of problem in Figure 1, there are problem of low output and incomes form agricultural production and poor knowledge of new ideas in agriculture. Driving forces such as provision of technical advice, provision of inputs and financial resources by Fadama III project to farmers as well as inhibiting forces such as limited liquidity for purchase of seed, agro-chemical and fertilizer, and the cost of these inputs distort the state of equilibrium already existing, thus shifting them to the second stage, a stage of implementation. With the implementation of the ideas from Fadama III project and subsequent adoption of new technologies, the disequilibrium from the second stage is stabilized, this leads to stabilization of modified behaviour and a solution to the problem earlier perceived.

2.2.3 The Theory of Production

A production function defines the technological relationship between the level of inputs and the resulting level of outputs. If estimated econometrically from data on observed outputs and input usage, it indicates the average level of outputs that can be produced from a given level of inputs (Schmidt, 1986). An implicit assumption of production functions is that all firms (Farms in the case of Fadama III) are producing in a technically efficient manner, and the representative (average) farm therefore defines the frontier. Variations from the frontier are thus assumed to be random, and are likely to be associated with mis- or un-measured production factors. A technically efficient farm operates on the production frontier while a technically inefficient farm operates below the frontier and could be made efficient by increasing its output with the same input level or using fewer inputs to produce the same level of output. As such, the closer a farm gets to the frontier the more technically efficient it becomes (Ogunyinka and Ajibefun, 2003). Estimation of the production frontier assumes that the boundary of the production function is defined by “best practice” farms. It therefore indicates the maximum potential output for a given set of inputs. Some white noise is accommodated, since the estimation procedures are stochastic, but an additional one-sided error represents any other reason firms would be away from (within) the boundary. Observations within the frontier are deemed "inefficient", so from an estimated production frontier it is possible to measure the relative efficiency of certain groups or a set of practices from the relationship between observed production and some ideal or potential production (Greene, 1993).

2.2.3.1 The Stochastic Frontier Production Function

The Stochastic Frontier Production Function is used in economics for estimating technical inefficiencies of production. The model proposed by Battese and Coelli (1995) is an improved model over the traditional production function. Unlike the traditional production function, which considers a single input in isolation, the Stochastic Frontier production function measures relative efficiency, which could account for all factors of production simultaneously. The implicit assumption of production function is that all firms are producing in a technically efficient manner and the representative (average) firm therefore defines the frontier. Variations from the frontier are assumed to be random and are likely to be mis- or un-measured production factors.

The stochastic production frontier function as presented by Coelli (1995) is given as:

$$y_i = f(X_i, \beta + V_i - U_i) \quad \text{--} \quad 2.1$$

where:

y_i = the output of the i^{th} farm

X_i = a vector of input of the i^{th} farm

β = a vector of parameters to be estimated

f = a suitable functional form such as Cobb-Douglas or Translog

V_i = random variable which is assumed to be normally distributed with zero mean and variance σ^2 and independent of U_i .

U_i = are non-negative random variables which are assumed to account for technical inefficiency in production and are obtained by truncation of the normal distribution.

As presented in the model, the stochastic frontier has two error terms, unlike the traditional production function. One error term U_i accounts for technical inefficiency and the other V_i accounts for other factors such as measurement errors.

The inefficiency frontier model is presented as:

$$y_i = \exp X_i, \beta + (V_i - U_i) \text{ -- } 2.2$$

Variables remain as earlier defined.

A Cobb-Douglas Stochastic Frontier model takes the form

$$\ln y_{it} = \beta_o + \sum_{j=1}^{k} \beta_j + \ln x_{jit} + v_{it} + u_{it} \text{ --} 2.3$$

Where *ln* = the natural logarithm of the variables

$\sum$ = summation sign

Other variables remain as earlier defined.

The Cobb-Douglas production function was chosen because Pavelescu (2011) asserted that the translog production function imposes hard constraint on the result feasisibility, thus as the occurrence of an extended collinearity is favoured, the value of the parameters practically "explodes" as the production factors which are taken into account increase.

The values of the unknown parameters of the model are usually estimated by maximum likelihood, after making assumptions regarding the distribution of V_i and U_i which are often assumed to be normal and half normal respectively. Technical efficient farms are those that operate on the production frontier and the level by which a farm lies below its production frontier is regarded as the measure of technical inefficiency. Allocative (or price) efficiency refers to the ability of the firm (in this case the farmer) to choose its inputs in a cost-minimizing manner. For allocative efficiency to hold, farmers must equalize their marginal returns with true factor market prices. Thus, technical inefficiency is related to deviations from the frontier isoquant, while allocative inefficiency reflects deviations from the minimum cost input ratios. In addition to technical and allocative efficiency, Farrell (1957) defined the concept of overall efficiency (renamed economic efficiency by later literature), as the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology (Farrell 1957). It is derived by multiplying the technical and allocative components of efficiency.

2.2.4 Sustainability Assessment of Farming and the Environment (SAFE) Model

Sustainability Assessment of Farming and the Environment (SAFE) Framework is hierarchical, it is composed of principles, criteria, indicators and reference values in a structured way. Principles are related to the multiple functions of the agro-ecosystem, which go clearly beyond the production function alone. The multifunctional character of the agro-ecosystem encompasses the three pillars of sustainability: the environmental, economic and social pillars. Criteria are specific objectives, more concrete than principles and relating to a state of the system, and therefore easier to assess and link indicators. The SAFE model is presented in Figure 2.

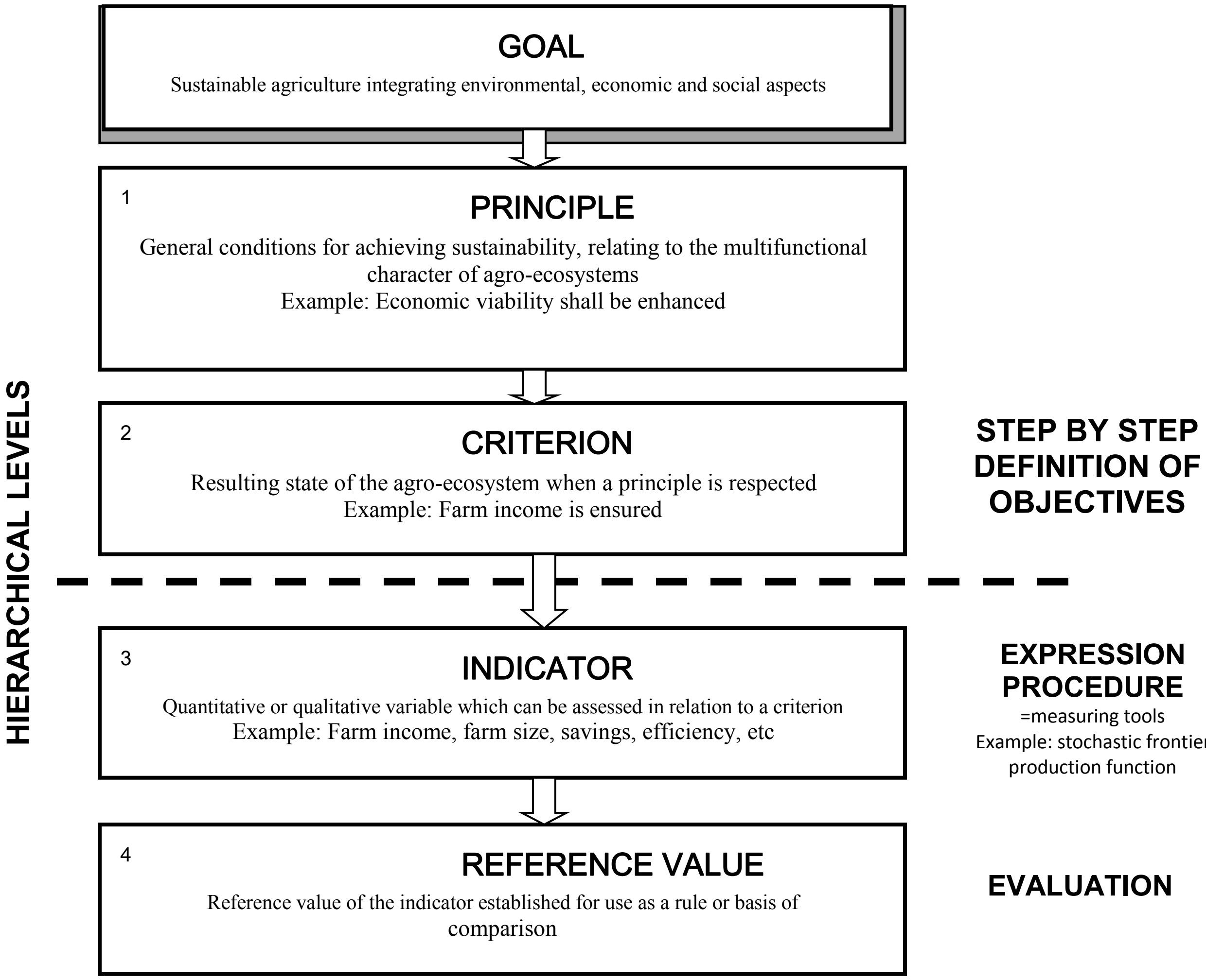


Figure 2: Sustainability Assessment of Farming and the Environment (SAFE) Framework

Adapted from Van Cauwenbergh *et al.*, (2006)

Indicators and reference values are the end-products of the framework. They are the operational tools that are used for evaluating the sustainability of the agro-ecosystems. If absolute reference values (such as norms) are not available, then indicator values are scored using a relative scale. Indicators form the third hierarchical level and are variables of any type that can be assessed in order to measure compliance with a criterion. Indicators describe features of the agro-ecosystem Reference values form the fourth and lowest level of the hierarchical framework and describe the desired level of sustainability for each indicator. They give users guidance in the process of continuous improvement towards sustainability. If absolute reference values (such as norms) are not available, then indicator values are scored using a relative scale. In this study, only the ecomomic aspect of sustainability was measured, also economic principle, criterion and indicators were developed to measure the sustainability of the Fadama III interventions in Benue State.

2.2.5 Theoretical Link to the Research Problem

Linking these theories to the research problem, the endogenous growth theory propose that to sustain a positive growth rate of output per capita, there must be continued advances in technological knowledge in the form of new goods, new markets or new processes and that technological progress takes place through innovations. The adoption behaviour model seeks that individuals accept and put into practice these innovations, but the adoption of these innovation is a result of the behaviour of individual which needs to be modified and is seen as resulting from the psychological fields of inhibiting and driving forces. These forces influence farmers' decision making thus affecting their efficiency of production. Thus, the stochastic frontier production function estimates inefficiencies in production and the factors responsible for such inefficiencies. Finally, the Sustainability Assessment of Farming and the Environment (SAFE) used variables like adoption of improved technology, efficiency of production and farming experience to assess and develop indices of sustainability of Fadama III beneficiaries in Benue State.

2.3 Empirical Literature

2.3.1 Agricultural Sustainability

Westers (2012) evaluated sustainability statuses of shrimp farms in two Sri Lankan provinces. Using the Sustainable Assessment of Farming and the Environment (SAFE) model and the

Framework for Assessing the Sustainability of Natural Resource Management Systems (MESMIS) model, the results showed that farms in the more established North Western Province, despite having disease problems, had higher sustainability scores than farms in the Eastern Province. Variables such as disease outbreaks and poor water quality were the driving force that increased implementation of sustainable practices. Additionally, farms that followed best management practices were less likely to report disease. The study recommended that the implementation of best management practices be encouraged. Like Wester's work, this research has used the SAFE model to evaluate the sustainability of livestock, agro-processing and crop farmers benefitting from Fadama III project in Benue State.

Ameen, Manrique and Olaizola (2011) analyzed the sustainability of sheep farming systems using the Sierra y caňones de Guara Natural Park in Spain. Several indicators of sustainability were designed using the SAFE framework. The study revealed that the sheep farms that were large in size had big flocks and widely available grazing areas were economically and socially very sustainable, whilst the smaller sheep farms with relatively important cereal production, and smaller flocks were also socially very sustainable. Like Ameen *et al's.*work, the SAFE model was used in this research work, but restricted to economic sustainability.

Dantsis *et al*. (2010) propose a methodological approach to assess and compare the sustainability level of agricultural plant production systems on regional scale combining the three pillars of sustainability, namely, environment, economy and society. Using the Multi-attribute Value Theory (MAVT), the proposed methodology was tested on two geographical regions in Greece. They analyzed it according to the contribution of different indicators to the final goal of sustainability, indicating which region could reach the higher level of sustainability. They pointed out the variability of different aspects among regions, demonstrating the principal problems that have to be solved to reach sustainability. Dantsis *et al.*'s work assessed the sustainability level of agricultural plant production, but this research work has gone futher to examine the sustainability of not only crop farming, but also livestock and agro-processing farming in Benue State.

Writing on Sustainable Agriculture and Food Security in Africa, Kleemann (2012) analyzed the challenges of meeting the food security needs in a sustainable way using the three dimensions of sustainable development; economic, social and ecological. Organic farming was used as an example for a sustainable development strategy for African agriculture and nutrition; it was recommended that organic farming could be one possible approach to create a more sustainable agricultural system in Africa. Kleemann's work concentrated on the use organic farming for a sustainable development of agriculture in Africa, yet, in most African countries Nigeria inclusive, it is often very difficult to find organic manure on a large scale to use on large farm sizes.

Wanderi, Mburu, and Guthiga (2013) used Contingent Valuation Approach to estimate the economic value of changes in soil quality. Data obtained from farmers in Eastern and Central Kenya, were used to empirically analyze the environmental benefits of compliance with agri-regulation (GLOBALGAP) standards. Further, factors influencing the economic value of changes in soil quality were analyzed. Compliance was found to have quantifiable environmental benefits to smallholder farmers as seen by the higher economic value of changes in soil quality and the positive and significant influence of compliance on the economic value of changes in soil quality. The study recommended that Agri-regulation was a useful tool that can be applied to enhance sustainability in Africa's increasingly intensive agriculture. While Wanderi *et al.*(2013) recommended agri-regulation to be applied in crop production to enhance sustainability in Africa's agriculture, this work goes a step further to examine not only regulations of the Fadama

III project in crop production but also livestock production and agro-processing in enhancing sustainability of agriculture in Benue State of Nigeria.

2.3.2 Agricultural Sustainability in Nigeria

Ibrahim and Omotesho (2009) assessed the sustainability of vegetable production under Fadama, based on the value of the Sustainability Index (Z_0 = 422). They found that the system of vegetable production under Fadama in the Northern Guinea Savannah Zone of Nigeria was not sustainable. The introduction of long term participatory soil improvement strategies such as integrated soil fertility management (ISFM) relevant to Fadama lands was recommended as vital to improving the sustainability of crop production under Fadama. Ibrahim and Omotesho's work assessed only the sustainability of vegetable production of the Fadama project. As an improvement on that, this research work has gone further to assess other crops like the sustainability of yam, rice groundnut and cassava production.

Lawal, Omotesho and Adewumi (2010) assessed the sustainability of food crop production in the Fadamas of Southern Guinea Savanna of Niger State. The study determined profitability of food crop production in the Fadama and identified the pattern of land use and management and its effects on sustainability of Fadama. The data were analyzed by using descriptive statistics such as frequency distribution, mean, standard deviation. In addition, estimates of crop diversification index (CDI), nutrient intake index (NII), Ruthberg index and farm budgeting model were utilized. The result showed that the average return on investment for all the farms studied was 1.89. Mixed cropping, the dominant cropping system generally adopted by the Fadama farming households gave higher gross margin per hectare. The study concluded that production of food crop in the Fadama of the Guinea Savanna of Niger State, Nigeria is sustainable. Lawal *et al.*'s work assessed the sustainability of food crop production in the Fadamas of Southern Guinea

Savanna of Niger State, but this research work has gone futher to examine the sustainability of not only food crop farming, but also livestock and agro-processing farming in Benue State.

Olatundun, Ajiboye and Akinsulu (2011) examined the Sustainable Resource Productivity in Small Scale Farming in Kwara State. The Cobb-Douglas production function and linear programming were used to analyze the data. By comparing the Marginal Value Product (MVP) to the Unit Factor Cost (UFC) of the resources employed, it was established that land and capital resources were over utilized. The linear programming analysis also showed that the most profitable and sustainable crop combination in the area was maize and cassava, which had a gross margin of ₦108,920.80/ha. In this research work the Stochastic Frontier Cobb-Douglas production function has been used to analyze Fadama III farmers' productivity of not just crop farmers, but also agro-processing and livestock farmers.

Nwaiwu, Ohajianya, Orebiyi, Eze and Ibekwe (2013) examined the determinants of agricultural sustainability of cassava based food crop farmers in Southeast Nigeria. Using descriptive statistical tools and ordinary least squares multiple regression analytical tools, the result showed that factors such as farm size, annual income, household size, level of education, and climate change were significantly and inversely proportional to sustainability level of farmers, while labour cost was significantly but directly proportional to agricultural sustainability. It was recommended that, efforts should be made at both micro and macro levels of government to improve on the mitigation and adaptive strategies of climate change available to farmers by making such more affordable, available and user friendly through extension education on the appropriate uses of such technologies in a more sustainable manner. Nwaiwu *et al*.'s work failed to measure agricultural sustainability using sustainability indicators; instead they constructed a sustainability index using sustainable and unsustainable inputs without clearly explaining which input were sustainable and which were unsustainable. Furthermore, their work failed to capture savings as a key variable in enhancing sustainability.

Bakare (2013) examined the relationship between sustainable agriculture and rural development in Nigeria. The Vector Auto Regression (VAR) analytical technique was employed for the empirical study. The results of the finding showed that the past values of agricultural output could be used to predict the future behaviour of rural development in Nigeria. The conclusion of this study was that while agriculture remains dominant in the Nigerian economy, it was unsustainable. The study recommended the need for policy makers to promote agriculture to a sustainable level. Bakare's work used secondary (longitudinal) data to conclude that agriculture was not sustainable in Nigeria. This research work has used farm level (cross-sectional) data to measure sustainability and find out if agriculture is sustainable or not in Benue State of Nigeria.

Iwala (2014) conducted a study to assess the economic impact, viability and sustainability of the Fadama Phase III sponsored small-scale infrastructure in different communities of Ondo State, Nigeria. Nine Local Government Areas (LGAs) were randomly selected out of the 18LGAs participating in Fadama III project. A Likert-like perception tool was used to investigate respondents' perception of sustainability of the projects. Descriptive statistics like frequency, percentage and mean score were used to analyze the data. Economic impact analysis of the projects showed that the average annual gross margin of beneficiaries (participants) had increased by 28.57% in the fourth year of project implementation. The viability analysis revealed that, the net project values (NPVs) of all the projects were positive at 26% discount factor. Also, their Benefit/Cost Ratios (BCRs) were greater than 1 and the Internal Rates of Return (IRRs) were all above average. It was recommended that, government at all levels and even development partners should emulate or adopt the Community Driven Development (CDD) approach of Fadama III project for poverty reduction, food security and sustainable rural development in Nigeria. Iwala's work concentrated on the sustainability of the Fadama III project's sponsored small-scale infrastructure for analysis without considering other components of the Fadama III project. Also the issue of savings which is crucial to the sustainability of fadama III project was not addressed. Other components such as advisory services and input support and asset acquisition also affect the sustainability of Fadama III project of which this work has addressed.

2.3.3 Adoption of Agricultural Practices

Data from a survey of West Virginia farmers were used by D'Souza, Cyphers, and Phipps (1993) in a logit model to determine the characteristics associated with the adoption of sustainable agricultural practices. Human capital characteristics such as a producer's age and education were found to be significant determinants of the adoption decision with the exception of off-farm employment. The study recommended that future research is needed to focus on or resolve issues such as the intensity of adoption, and substitution or complementary between practices constituting a sustainable production system. Like D'Souza *et al.'s* work, the logit model has been used in this research work to determine the factors affecting the adoption of improved technology by Fadama III farmers in Benue State.

Binoo, Bonny and Vijayaragavan (2001) developed a Farmer sustainability index (FSI) to measure the adoption of sustainable practices by traditional rice growers of Kuttanad agro-ecosystem in Kerala. Based on the mean FSI scores of each group, the groups were named as conventional and sustainable. The results indicated a wide range between the mean FSI scores of conventional (23.95) and sustainable (70.06) adopter categories. The conventional and sustainable adopter categories maintained significantly distinct positions on all selected practices and also on the overall total FSI scores. This proved that the conventional and sustainable groups acted differently on all production practices in concordance with their technological allegiance. This research work goes further than examining the sustainability of not only rice growers but other crops like yam, cassava and groundnut.

Uaiene, Arndt and Masters (2009) analyzed the determinants of agricultural technology adoption in Mozambique. Using the probit model, the analysis of improved agricultural technology adoption indicated that households with access to credit and extension advisory services as well as members of agricultural associations were more likely to adopt new agricultural technologies. Households with higher levels of education were also more likely to adopt. Finally, the results suggested that a scheme that provides credit to farms can help stimulate agricultural technology adoption. Instead of the probit model used by Uaine *et al.,* this research work has used the logit model to analyze the factors affecting the adoption of technology by Fadama III farmers in Benue State.

Tey, *et al.* (2012) conducted an exploratory study to identify the adoption rate of Sustainable Agricultural Practices (SAPs) in the Malaysian vegetable sector. Using focus group discussion with the Department of Agriculture, they found that there are varied adoption rates across SAPs. The outputs also pointed out that the adoption of SAPs was currently at a low level, like most countries. The study recommended that the phenomenon be further investigated from a multi-disciplinary perspective within agricultural systems, integrating socio-economic factors, agro-ecological factors, institutional factors, informational factors, perceived characteristics, and behavioral attributes. This study failed to use the farmers as their target population in analyzing the adoption rate of sustainable agricultural practices in Malaysia; instead they used information from the Department of Agriculture for their analysis.

Teklewold, Kassie and Shiferaw (2012) analyzed the factors that facilitate or impede the probability and level of adoption of interrelated sustainable agricultural practices (SAPs), using data from multiple plot-level observations in rural Ethiopia. Multivariate and ordered probit models were applied to the modeling of adoption decisions by farm households facing multiple SAPs which could be adopted in various combinations. The result showed that there was a significant correlation between SAPs, suggesting that adoptions of SAPs are interrelated. The analysis further shows that both the probability and the extent of adoption of SAPs are influenced by many factors: household's trust in government support, credit constraints, spouse education, rainfall and plot-level disturbances, household wealth, social capital and networks, labor availability, plot and market access. They recommended that policy makers and development practitioners should seek to strengthen local institutions and service providers, maintain or increase household asset bases, and establish and strengthen social protection schemes, to improve the adoption of SAPs. . Instead of the probit model used by Teklewold *et al.,* this research work has used the logit model to analyze the factors affecting the adoption of improved technology by Fadama III farmers in Benue State.

Beshir (2014) examined the factors affecting the probability of adoption and intensity of use of improved forage technologies in mixed farming systems in two districts of south Wollo zone, in Ethiopia. A double hurdle model was employed using data collected from randomly selected 252 farmers between July 2009 and November 2009. The study revealed low utilization of improved forage seed which covered only 1.3% of total cultivated land in Ethiopia. The results of the study provided empirical evidence of a positive impact of extension and credit service in enhancing the probability of adoption of improved forage technologies. The intensity of use of improved forage in the study area was influenced by labour available, size of livestock ownership and farm size. Physical characteristics like distance from farmers' home to all weather roads, markets and input supply played a critical role in the adoption of improved forage technologies. Based on the results, it was suggested that the adoption of improved forage should be enhanced by raising farm household asset formation, and providing extension and credit services. Instead of the double hurdle model used by Beshir, this research work has used the logit model to analyze the factors affecting the adoption of improved technology by Fadama III farmers in Benue State.

Shimayohol, (2013) conducted a study to assess the adoption rate of technologies by Fadama III beneficiaries in Benue State. Using descriptive statistics, the study showed that yam, cassava and maize were main crops adopted by both beneficiaries and non-beneficiaries. Adoption rates were higher for beneficiaries than non-beneficiaries and the improved ruminants adopted were goats and sheep while non-ruminants were poultry, swine and rabbit. The study suggested that more attention should be given to vulnerable groups, women and youths to enhance the adoption rate in order to achieve the projects overall aspiration of reducing poverty in the intervention areas. Shimayohol's work has analyzed the adoption rate of Fadama III in Benue State Using simple descriptive tools of means and percentages. This research work has not only use descriptive tools but also inferential tools such as the Logit regression model in analyzing the adoption of improved technology by Fadama III beneficiaries in Benue State.

2.3.4 A Review of Fadama I

Adeolu and Alimi (2004) assessed the potential of the National Fadama (lowland irrigation) facility to enhance smallholder farmers' production and income thereby lifting them out of the vicious circle of poverty in South Western Nigeria. The stochastic frontier production function model was utilized to estimate the technical efficiency level of the participants. Results obtained showed that the farm income obtained from Fadama cultivation increased about three times from ₦ 13368.00 at baseline to ₦ 38918.00 at the end of the project. The stochastic production function results obtained shows the coefficients of age of farmer, number of children and farming experience being significant at 1% while the coefficient of cost of seed was significant at 10% level. The range at technical efficiency obtained was 0.9959-0.9964 suggesting a relatively efficient level of production by the participants. They concluded that the programme had the potential of alleviating the participants from poverty. This work has gone further than Adeolu and Alimi's work to examine not only income of Fadama III beneficiaries but also savings and adoption of technology as factors affecting their technical efficiency.

Oladoja and Adeokun (2009) appraised the National Fadama Development Project in Ogun State using multiple regression analysis, chi-square (χ^2) and the Pearson Product Moment Correlation. The study found that age, family size, gender, educational level and frequency of extension contact made significant contribution to the prediction of the adoption of tube well/wash bore, improved seeds and inorganic fertilizer. Recommendations included the provision of credit facilities to the Fadama farmers and adequate mobility for the extension staff of the project to help improve the farmers' productivity. In addition to these variables, savings of Fadama III farmers was used to analyze the adoption of improved technology in Benue State.

Ajayi and Nwalieji (2010) evaluated the Fadama phase-one vegetable production project of the Anambra State Agricultural Development Project. Percentage, mean scores, factor analysis, t-test, and chi-square statistics were used in the data analysis. The result of the study indicated that telfaria and okra production were most preferred to other vegetables during dry and wet seasons, respectively, mainly due to their high income generating capacity, high market demand, high yielding capacity and usefulness to the family. It was therefore, recommended that there should be timely and adequate provisions of Fadama inputs and infrastructure; and that low cost but improved technology for storage, transportation, processing and marketing of Fadama vegetable produce should be introduced by the National Fadama Development Project (NFDP) management. This research work has gone further by analyzing other crops like rice, yam, cassava and groundnut under Fadama III in Benue State.

Sulaiman, Ja'afar-furo, Nasiru, Haruna and Ochi (2011) examined the influence and relationship of socio-economic characteristics of the Fadama Resource Users on conflicts incidence in Fadama areas in Bauchi State. The data which was collected from arable farmers and pastoralist was analyzed using correlation and multiple regressions. The results showed that from the arable farmers, land size, total cost and savings had strong but negative relationship with conflict incidence at $p<0.001$. Education was also negative but significant at $p<0.01$. Herd size, accessibility to grazing reserve, saving were significant at $p<0.001$ for the pastoralists. The outcome of the study revealed strong relationship of all the selected variables with incidence of conflict except marital status and experience for the arable farmers. It was recommended that Fadama area communities especially that of the pastoralist needed improvement in their education status and more grazing reserve should be provided by relevant authorities to ease accessibility to pastures and invariably reduce conflict incidences. Unlike Sulaiman *et al*.'s work where the analysis was on both arable farmers and pastoralist, this research work has analyzed only arable farmers benefitting from the Fadama III project in Benue State.

Folayan (2013) examined the socio-economic analysis of Fadama farmers in Akure South Local Government Area of Ondo State. The data collected was analyzed by use of percentage, frequency, descriptive statistics, gross – margin and regression analysis. The findings from the study showed that, all (100%) the respondents had one constraint or the other with the suggestion of new technology, adequate funding and improved input supply and provision of infrastructure to cushion their problems. The gross margin per annum of Fadama farmer was ₦254, 000 with

₦21, 166.6 per month showed that Fadama farming was profitable in the area of study. The regression analysis result showed that increase in the values of marital status, household size, level of education, experience and farm size increase Fadama farmer's productivity while an increase in age and gender reduce the rate of Fadama farming productivity in the study area. It was recommended that education of farmers should be encouraged while soft loan, agricultural inputs and research assistance be provided by government. Unlike Faloyan's work, this research work has used logit regression analysis in analyzing the factors affecting the adoption of improved technology by Fadama III beneficiaries in Benue State.

2.3.5 A Review of Fadama II

Kudi, Usman, Akpoko and Banta (2008) examined the impact of National Fadama Development Project II on the socio-economic status of the farmers in Giwa Local Government Area of Kaduna State. The analytical tools used include descriptive statistics and stochastic frontier production function, which incorporated technical inefficiency model using the maximum likelihood estimation (MLE). The study revealed that the technical efficiencies were positively and significantly correlated with years of irrigation farming, number of visits by extension agents, level of education household size and ownership of water pump. They recommended that policy interventions that contribute to better access to inputs should be upheld. Unlike Kudi *et al.*'s work that examined only crop farmer under Fadama II project in Kaduna State, this research work has also analyzed livestock and agro-processing farmers' benefitting from the Fadama III project in Benue State.

Babatunde, Fakayode and Obafemi (2008) examined the economics of fadama maize production in Kwara State; they found that the average gross margin was 75707 naira per hectare (US $ 631) and 1676 naira per man-day (US $ 14). This suggested high profitability of fadama maize production. Purchased inputs and labour were the major determinants of fadama maize output. To achieve the objective of the second Fadama Development Project of increasing food production in Nigeria, it was recommended that, in addition to providing loan for fadama farmers to procure other necessary inputs, purchased inputs-like seed, agrochemicals and fertilizer should be given to them to boost their output. Adaptable, simple and low-cost fadama production technology should be developed for fadama farmers to reduce the current level of labour inefficiency. Unlike Babatunde *et al.*'s work that examined only maize farmer under Fadama II project in Kwara State, this research work has also analyzed rice, cassava, yam and groundnut farmers' benefitting from the Fadama III project in Benue State.

Nwachukwu *et al*. (2008) evaluated the Second National Fadama Development Project in Nigeria. They found out that as at mid–term, beneficiaries had increased their income by about 25%. An estimated 2.3 million Fadama households had benefited from the expansion in incomes and wealth (asset) derived from the previously unavailable services provided by the project. The project had created about 126, 000 permanent jobs and an additional savings of more than $40.8 million which had been realized by the majority of the participating states. Nwachukwu *et al.* evaluates the Second National Fadama Development Project in This research work has evaluated the sustainability of the third National Fadama Development Project in Benue State.

Nkonya *et al.* (2008) assessed the impacts of Fadama II, a Community-Driven Development (CDD) project and the largest agricultural project in Nigeria. The study used double difference methods to compare the impact indicators. The results showed that Fadama II project succeeded in targeting the poor and women farmers in its productive asset acquisition component. Participation in the project also increased the income of beneficiaries by about 60 percent, which was well above the targeted increase of only 20 percent in the six year period of the project. The unique feature that could have contributed to the significant impact of the project in a short time was its broad-based approach, which addressed the major constraints limiting the success of CDD projects that address only one or two constraints. This has implications on planning poverty reduction efforts in low-income countries. Given that the poor face numerous constraints, they suggested a CDD project that simultaneously addressed many constraints and would likely build synergies that would lead to larger impacts. The need for government and donors to pool resources and initiate multipronged CDD projects rather than many isolated projects was also suggested. Unlike Nkonya *et al.,* this research work has evaluated the sustainability of Fadama III project in Benue State using other methods like the logit regression analysis and the stochastic frontier production function.

Vosanka, Madugu and Donye (2008) evaluated the participation of beneficiaries in fadama II project in Taraba State. Data was analyzed using both descriptive and inferential statistics. Results showed that incomes of the respondent who participated in the pilot asset acquisition support (PAAS) component of the fadama II project increased by 36 per cent. Further analysis revealed that a significant relationship existed between the respondents' participation and effect such as income, expenditure on family welfare and asset/equipment. The study recommended that PAAS component of the fadama II project be sustainably implemented in all Local Government Areas of the country. Unlike Vosanka *et al*.'s, work that evaluated asset acquisition component of Fadama II project in Taraba State, this research has not only evaluated asset acquisition component of the Fadama III project, but also other components like capacity building, communication and input support, small-scale community-owned infrastructure, advisory services and input support and support to the Agricultural Development Projects (ADPs) and sponsored research.

Adegbite *et al.* (2008) assessed the impact of National Fadama Development Project II on Small scale farmers' income in Ogun State. Results obtained showed that there was inadequate infrastructural and storage facilities, inadequate capital for the farm operations, insufficient access to micro-credit facilities and other support services by members of the Fadama endowed communities. The need to implement policies, through mandatory bank lending to agricultural sector participants was recommended. Adegbite *et al.'*s work concentrated on the impact of Fadama II on farmers' income, but this research work has evaluated not only income of farmers, but their savings, adoption rates and efficiency of production of Fadama III farmers in Benue State.

Shimayohol (2010) examined the factors that determine the Fadama users group characteristics that influence the role performance effectiveness of facilitators in the NFDP-II. Data analysis was done by use of percentage, mean and logic regression. The results of the study showed that there was low cohesiveness, low interaction with other groups and discriminating status hierarchy which implied that the characteristics were not yet adequate for role performance effectiveness of facilitators. Also only economic disposition of FUGs determined facilitators' role performance effectiveness. It was recommended that group formation should be based on economic disposition of members of the FUGs because only economic disposition of FUGs determine facilitators role performance effectiveness. Other than assessing the facilitators of Fadama II, this research work has evaluated the income, savings and efficiency of beneficiaries of Fadama III project in Benue State.

Balogun, Adeoye, Yusuf, Akinlade and Carim-Sanni (2011) examined production efficiency of farmers under the National Fadama-II Project in Oyo State. The analytical framework used for the study include: descriptive, infrastructure index, gross margin and stochastic frontier production function. The result showed that the presence of infrastructure of Fadama-II project has impacted on efficiency of resource use among the beneficiary. There was therefore the need to improve on community driven development programme like Fadama II and on coming Fadama III project or any developmental project, so as to further impart more technical and economic knowledge to farmers. Balogun *et al.*'s work is on effect of infrastructure on efficiency of production, this research work has examined the socio-economic factors affecting the efficiency of production by Fadama III beneficiaries in Benue State.

Akangbe, Ogunyinka, Ayanda, Achem and Adisa (2012) determined the influence of Fadama II on farmers' livelihood in Orire Local Government Area of Oyo State. Descriptive statistics were used for the analysis. They affirmed that the Fadama project increased employment opportunity, income and minimized constraints of agricultural production. The result also showed that a significant relationship existed between access to irrigation pump, fertilizer and credit between Fadama and non-Fadama farmers. It was recommended that the scope of the project be expanded to cover all farmers in the state and most farmers in the country because of its potential to boost food production. Other than crop production, this research work has analyzed the productivity of livestock, and agro-processing production of Fadama III farmers in Benue State.

Olaolu, Akinnagbe and Agber (2013) examined the National Fadama Development Project (II) as a panacea to poverty and food insecurity among rice-farmer beneficiaries in Kogi State. Two Fadama Community Associations (FCAs) were randomly selected from four selected LGAs. Descriptive statistics like frequency, percentage and mean score were used to analyze the data. Foster, Greer and Thorbecke (FGT) poverty model and food security model were used to determine farmers' food security status and poverty level. The food security analysis of the farmers revealed there was an increase of 2.8% of the beneficiaries who were food secure after the project. The project had an appreciable impact on poverty reduction of the farmers by a change in the poverty incidence by 66.8% and 96.0% change in the poverty depth. It was recommended that the approach of the National Fadama Development Project phase II be adopted for rural development in Nigeria going by the impact of the project. Unlike Olaolu *et al.*'s work that examined only rice farmer under Fadama II project in Kogi State, this research work has not only analyzed rice farmers, but also cassava, yam and groundnut farmers' benefitting from the Fadama III project in Benue State.

2.3.6 A Review of Fadama III

Ike (2012) analyzed the Impact of Fadama III Project on Poverty Alleviation in Delta State; the Double-Difference (DD) Estimator was used to compare changes in outcome measures. The real income of Fadama III beneficiaries increased by about 36.67 % (From ₦62, 480.00 to ₦85, 391.42) as a result of participation in the project. About 45.43% of the beneficiaries increased their incomes by at least 25% in the first year of Fadama III operation. The mean increase in income for participants in Fadama III was significantly different from that of non participants. The study recommended that appropriate policy to ensure proper education of rural populace should be advocated. Ike's work used only income in his analysis; this work has looked at other variables like savings, adoption of technology and sustainability of Fadama III project as a panacea to poverty alleviation.

Omoregbee and Onemolease (2013) examined the socio-economic factors affecting Fadama farmers' productivity in Edo State. Data analysis revealed the average yield of respondents was 202.38kg. Adoption of Fadama-related technologies was low and participation in Fadama projects was also low. Respondents were about 37 years old, with low literacy level and fairly large household size (8). Respondents' productivity was significantly related to participation in

Fadama project (b = 0.335), education (b = 0.540) and family size (b = 0.601). The study therefore recommended active farmers involvement in Fadama projects as well as upgrading their educational status through adult literacy classes and/or extension (ADP) training sessions. Other than crop production, this research work has analyzed the productivity of livestock, and agro-processing production of Fadama III farmers in Benue State.

Agberavo and Age (2013) conducted a study to assess the effect of Fadama III project on the incomes of the participants in Kwande Local Government of Benue State. The study area was stratified into four, namely: Nanev, Turan, Shangev-ya and Kyurav-ya clans. Twenty-five participants were selected from each stratum, giving a sample size of 100 farmers. The data collected was analyzed using the mean and population t-test to test the significance of the difference between the sample and population means at 95 confidence level ($P \leq 0.05$). The difference between the sample mean of 4.46 and population mean of 4.47 was not significant. Hence, the farmers were unanimous that their participation in Fadama III project has significantly increased their incomes. Other than income, this work has looked at other variables like savings, adoption of technology and sustainability of Fadama III project in Benue State.

Sani, Kushwaha, Abubakar and Ayoola (2011) conducted a study to examine the sustainable vegetable farming under fadama condition in Dass Local Government Area of Bauchi using selected crops: onion, tomato, pepper, okro, carrot, cabbage and garden-egg. Three (3) categories of farmers were formed, namely, below 1, 2 to 3.99 ha, and 3 to 4.99 ha consisting of 37, 39 and 20 farmers, respectively. The benefit-cost ratios for the major vegetable crops showed a consistently increasing trend for all categories of the sampled farmers due to joint family labor. It was therefore recommended that the Government should play supportive roles of enabling environment for sustainability to be achieved. Other than vegetable crop farming, this research work has examined rice, yam cassava and rice farming under Fadama III project in Benue State.

Umeh (2011) assessed the key drivers of empowerment which are household income generation, progression and sustainability. Data generated were analyzed using descriptive statistics. The results showed that the average income levels across the four major EIGs for Fadama III were Livestock (₦189,550), Fisheries (₦207,200), Crop (₦163,700) and Storage/processing (₦191,680). Fadama III scaled far above the un-disaggregated average income of ₦32,984 at baseline. The average income for the non-Fadama III beneficiaries (control) across the EIG was generally low, the highest being ₦98, 950 for Storage / Processing. Greater performance was however expected in the crop EIG. The study recommended that the project could re-assess its implementation process to scale up its performance degree especially in the crop EIG. Umeh's work used only descriptive analysis, this research work has gone further to use inferential tools like the stochastic frontier production function and the logit regression model in the analysis of Fadama III project in Benue State as this is expected to give more robust result.

Shimayohol (2011) assessed social capital formation and implications for the achievement of Fadama III project development objective. Data generated were analyzed using descriptive statistics. The extent of adherence of group formation to the principles of social inclusion, transparency and accountability was high in the group under Fadama III project. Results showed that the functionality of FUGs in terms of counterpart fund contribution, savings mobilization and asset acquisition and maintenance and group cohesion was high. The study recommended that the scope of participation, demand-driven mechanism and subproject ownership should be sustained. However, problem identification, prioritization and LDP development should be given more attention. Shimayohol's work used only descriptive analysis; this research work has gone further to use inferential tools like the stochastic frontier production function and the logit model in the analysis of Fadama III project in Benue State.

Ojowu (2011) assessed the contributions of Advisory Services and Input Support and Support to ADPs and Adaptive Research to the attainment of the Fadama III project development objective in Benue State. Results showed that access to agricultural inputs was large as fadama III provided 71% of beneficiaries' with improved seeds and 40% with fertilizer. The study recommended timely delivery of support services to beneficiaries and gender equality.

Abu (2011b) examined the contribution of Small-scale Community Owned Infrastructure and Asset Acquisition to the attainment of Fadama III project development in Benue State. Results revealed that most communities (96%) had at least one infrastructure facilitating improved marketing in the Fadama III communities. Considerable processing activities were carried out in cassava and rice with the resultant increase in income. Women and other vulnerable groups were adopting improved technologies for maximum benefit to their investments. The study recommended that more roads and culverts should be rehabilitated for the communities as this would facilitate wider market access.

Shimayohol (2011), Ojowu (2011) and Abu (2011b) did not only use simple descriptive statistic, but they also examined the Fadama III project only at mid-term. This study has not only examined Fadama III project at the end of the project, but it has also used inferential tools like the stochastic frontier production function and the logit regression model in the analysis of Fadama III project in Benue State, this is expected to give more robust result.

Ater and Umeh (2011) assessed productive efficiency, income and quality of life improvement among fadama land users in Benue State. Using descriptive statistics, stochastic frontier production function, discriminant-function and t-statistics, the result revealed that Fadama land use efficiency improved from 52% to 96%, valued farm firm's productivity recorded a significant shift from US$486.5 to US$1120.4 for an average holding of 0.70 hectare. Respondents before assistance spent more on water delivery, had higher off- farm family labor man days (13) as against (6) after intervention. Quality of life score (9) at post intervention was higher than the score (3.0) before intervention. The total distance difference at pre and post-implementation was significant giving the discriminant (Z) score of 80%. The study concluded that World Bank assistance impacted positively on efficiency, productivity, income and quality of life. The research recommended increased financial assistance to Fadama producers for rapid income increase, quality of life improvement, economic growth and development in Nigeria as well as developing economies generally to mellow down poverty. Other than income of fadama land users in Benue State, this research work has also analyzed the savings, adoption rate and sustainability of Fadama III beneficiaries in Benue State.

2.3.7 Socio-economic Factors and Agricultural Productivity

Muhammad-Lawal and Atte (2006) assessed the growth of the agricultural sector of the Nigerian economy. Descriptive statistics and regression analysis were the major tools of analysis. The study showed that the overall agricultural production average growth rate was 5.4% and that GDP growth rate, population growth rate, and the Consumer Price Index were the main factors affecting domestic agricultural production. This study recommended the need to increase per-capita productivity through the introduction of improved technology in agricultural production. This research has gone further by analyzing factors that affect the efficiency of production through the adoption of improved technology by Fadama III farmers in Benue State.

Asogwa, Umeh and Okwoche (2012) analyzed the relationship between poverty and efficiency among the farming households in Nigeria using farm level data from Benue State. The P-alpha measure of poverty and the Food Energy Intake (FEI) method were used for the measurement of poverty gap among the respondents, whereas Stochastic Frontier was used to obtain the efficiency estimates. Correlation analysis was used to achieve the objective of the study. The study showed that average level of technical, allocative and economic efficiency was estimated at 30%, 12% and 36%, respectively. Allocative inefficiency was worse than technical inefficiency, implying that the low level of overall economic efficiency was the result of higher cost inefficiency. The study further showed an inverse relationship between poverty gap and technical efficiency estimates among the respondents, implying that as average productivity increases, poverty decreases. Furthermore, the study showed a direct relationship between poverty gap and allocative efficiency estimates, implying that as the cost of technical efficiency increases poverty increases. The study also showed a direct relationship between poverty gap and economic efficiency estimates among the respondents, implying that as the cost of maximizing output increases poverty increases. Overall economic efficiency and hence poverty reduction among the respondents resulted more from technical efficiency than allocative efficiency. The policy implication is that poverty reduction among the farming households is linked with improving farm efficiency. They recommended that if poverty is to be eradicated among the farming households, farming activities must be efficient. Asogwa *et al.'s* work was on the efficiency of crop farmers in Benue State, but this research work has gone further to analyze the efficiency of not only crop farmers, but also livestock and agro-processing farmers benefitting from Fadama III project in Benue State.

Dauda *et al.* (2009) assessed the income generating potential of irrigation farming which may reduce poverty and hunger, and directly achieve an important aspect of the Millennium Development Goals. The result of the study showed that irrigation farming was a profitable venture, and was found to be capable of alleviating poverty among farming households because they were able to live above US $1/day/person which is the threshold for poverty level. The Ordinary Least Square (OLS) regression showed that farm size, years of irrigation experience, seed, labour and fertilizer were found to have significant effects on profit realized from irrigation farming. This research work has gone further than crop farming to analyze other areas like livestock farming and agro-processing.

Onoja, Ibrahim and Achike (2009) determined the technical efficiencies of farm credit to cassava farmers in Kogi State. The result showed that farm credit, farm size, chemical fertilizer quantity applied, labour and seedlings planted were significant determinants of cassava output. They recommended the need for policy interventions in farm credit access, the promotion of the use of organic fertilizer and adoption of improved varieties. This research work has not only analyzed the efficiency of cassava farmers but also rice, yam and groundnut farmers benefitting from the Fadama III project in Benue State.

Ovwigho (2012) analysed the impact of the live and own a farm programme of the Delta State Government. Data were analyzed using t-test and simple percentages. Results showed that the performance index in terms of input distribution was far below average (29.80%). It was found that only 40% of the activities were carried out and the target numbers of communal farms were established in the 25 Local Government Areas of the State. There was no significant relationship between socio-economic status of the beneficiaries before and after the programme. The study recommended that monitoring and evaluation is intrinsic to the success of development intervention programmes. The government should empower existing farmers through provisions of credit facilities and inputs instead of the orchestrated agricultural intervention programmes. Like Ovwigho's work, this research work has evaluated the Fadama III project in Benue State to assess the level of implementation of the project.

Okpe, Abur and Ominyi (2012) assessed resource use efficiency and Rice Production in Guma Local Government Area of Benue state. The analytical tools included gross margin and stochastic frontier production function. The results indicated that both yield and profit of small and medium scale farmers remained small, when compared with large scale farmers. Also the results from Maximum Likelihood Estimation showed that all estimated coefficients among various farm operations indicate positive sign which implies that increase in quantities of these inputs would result in increased output of rice. The results obtained from the Inefficiency model, indicated that the resource use in rice production in the study area was not fully utilized in all the categories of farms examined. Although farmers were generally relatively efficient, they still had room to increase the efficiency of their farming activities from 65%, 53% and 46% for small, medium and large scale farms respectively to close the efficiency gap to the optimum (100%). The technical returns to scale measured by the sum of the elasticity of all significant factors showed that small and large scale farms exhibited increasing return to scale while medium scale farms demonstrated decreasing return to scale. For pooled observation, the farms depicted constant return to scale. The study recommended that farm inputs should be made available to farmers at highly subsidized rates and timely, through adequate supply and efficient distribution. This research work has not only analyzed the efficiency of rice farmers but also cassava, yam and groundnut farmers benefitting from Fadama III project in Benue State.

2.3.8 The Research Gap

From the literature reviewed, it is observed that there is inadequate research on sustainability in the agricultural sector in Nigeria. Studies in this area are mostly from other countries. Scanty literature is available on the sustainability of the National Fadama Development Project across the Economic Interest Groups which are the different aspects of agriculture. Most empirical works done on the Fadama project, concentrated on one (crop) aspect of agriculture. Thus, there is need to assess if the different aspects (crop, agro-processing, livestock and fisheries) of agriculture as captured in the Economic Interest Groups have made gains in their productive activities and are sustaining the gains from the Fadama III project in Benue State. Furthermore, studies done by Adeolu and Alimi (2004), Dauda *et al.* (2009), Ike (2012) and Agberavo and Age (2013) amongst other on the Fadama project have dwelt on the incomes of Fadama farmers, this work has assessed other variables like savings and adoption of technology as factors influencing the sustainability of the Fadama project. The mid-term report by Shimayohol (2011), Ojowu (2011), Umeh (2011) and Abu (2011b) did not only show the use of simple descriptive statistic in the analysis, it also did not cover the entire life of the project. Thus, this research work has used inferential statistical tools such as logit regression analysis and Stochastic Frontier production function to examine the Fadama III project when it closed up. The use of inferential statistics is to estimate the properties of the population on the basis of a sample. The generalizations and recommendations made are expected to not only improve the performance of subsequent Fadama project, but also improve the agricultural sector in general.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 The Study Area

The study area is Benue State. The State is located between Longitudes 6^0 35'E and 10^0E and between Latitudes 6^0 30'N and 8^0 10'N. The State is on the Eastern side of the Middle Belt of Nigeria and is surrounded by five States, namely Nassarawa to the North, Taraba to the North-east, Cross River to the South, Enugu to the South-west and Kogi to the West. There is also a short international boundary between the state and the Republic of Cameroun along Nigeria's South-East border. Benue State is considered one of the least urbanized States in Nigeria with a population of 4,219,244 comprising of 2,164,058 males and 2,062,180 females (NPC, 2007). The State is categorized as one of the poorest States in the country where 67.1% her people are living below the poverty line (NBS 2012).

Benue State has abundant land estimated to be 5.09 million hectares. This represents 5.4 percent of the national land mass. Arable land in the State is estimated to be 3.8 million hectares (WARDROP, 1993; BENKAD, 1998). Although the fertile top soils of the plains are not so deep, their vast coverage provide the basis for the extensive form of peasant agriculture. The abundant lateritic materials are used for road construction. The burnt bricks industry is gradually taking over much of the few fertile alluvial deposits along the rivers and streams thus reducing the few arable lands that in the past have been profitably used for agriculture.

River Benue, one of the few large rivers in Nigeria not plagued with waterfalls and rapids is the dominant geographical feature in the State. The Katsina-Ala River is the largest tributary, while there are a number of smaller rivers. The flood plains which are characterized by extensive swamps and ponds are utilized for dry season irrigated farming. Though Benue State has high drainage density, many of the streams are seasonal, the permanent water table in many parts of the State is very low and there is an acute water shortage in the dry season in some Local

Government Areas. The numerous rivers and streams provide a great potential for irrigated agriculture, a source for fresh water fish, hydroelectric power and transport (BENSEEDS, 2004). Most part of Benue State lies in the Southern Guinea Savannah area**.** The natural vegetation, comprising grasses, trees and shrub is currently being used for grazin*g,* firewood*,* Timber, woodcarving, palm products fruit gathering and various construction purposes including building. This resource can also be used for water conservation, erosion control grassing reserves or game reserves**.** The succulent grasses can easily be harvested, dried and preserved for dry season livestock feeding. Some of the economic trees commonly found include the locus bean, shea-butter, mahogany, silk cotton, cashew, mango, orange and guava. Saw mills are fast increasing in number, whereas village and gallery forests are reducing in number and size. Agro forestry is fast gaining ground, particularly in those areas with higher population densities. Wood is the greatest source of fuel in the State. Agriculture is the main economic activity in Benue State. The state has variety of crops grown on both irrigated and rain-fed land, such as yam, cassava, rice, soya bean, beniseed (sesame), sorghum, millet amongst others. There are also plantation crops like oranges, mangoes and palms.

The State is made up of twenty-three Local Government Areas (LGA) grouped into three senatorial or geopolitical zones A, B and C. Zone A comprises of Logo, Ukum, Katsina-Ala, Vandeikya, Kwande, Konshisha and Ushongo LGAs. Zone B comprises of Buruku, Tarka, Gboko, Gwer, Gwer-west, Guma and Makurdi LGAs and Zone C is made up of Okpokwu, Otukpo, Oju, Obi, Ohimini, Ogbadibo, Ado, Agatu and Apa. Fourteen of these LGAs belong to the ethnic tribe of the Tiv people, seven belong to the ethnic tribe of the Idoma people and two belongs to the Igede people. The other smaller ethnic groups like the Etulo and Jukum fit into these major three senatorial zones mentioned.

3.2 Research Design

This study employed the survey method. This method was chosen because it is capable of obtaining information from large samples of the population. Survey designs are inclusive in the type and number of variables that can be studied and are relatively easy for making generalizations (Bell, 1996). Using a cross-sectional survey, the data for the study was generated through well-structured questionnaire which was administered to households and group leaders in the Fadama User Groups/ Economic Interest groups. Thus, information on the output of farmers, quantity of inputs, technologies adopted and other socio-economic characteristics were elicited from Fadama III beneficiaries.

3.3 Kinds and Sources of Data

This study made use of both primary and secondary sources of data. The primary data was sourced from households that benefited from the Fadama III project while the secondary data was sourced from the Benue Fadama Development Office, records from Local Development Plans, Journals, books and the internet. The data needs for the study are data on adoption rate of Fadama III beneficiaries in Benue State; data on variables such as output, farm size, sex, and labour were used for analysis. Also data on income, savings educational level, advisory and extension services were obtained to evaluate the sustainability of Fadama III intervensions in Benue State.

3.4 Population of the Study

The population of the study comprise of the entire Fadama User Groups (FUG) and households that benefited from the Fadama programme in Benue State. Three Local Government Areas

(LGA), one from each geopolitical zone were selected for this study. The Local Government Areas selected were Logo (Benue North-east), Buruku (Benue North-west) and Otukpo (Benue South). The three LGAs were selected because they had one of the highest representations of the FUGs and each FUG selected for the study, which represents a stratum, can be found in these LGAs (see Appendix III). Also, these Local Government Areas have a high number of funded FUGs. This is presented in Table 3.1.

Table 3.1: Number of FCA/FUG across LGA in Benue State

S/N	LGAs	No. of registered FCAs	No. of funded FCAs	No. of funded FUGs	Average No. of members
1	Katsina-	10	6	61	915

	Ala				
2	Konshisha	10	8	74	1110
3	Ushongo	10	9	114	1710
4	Logo	10	10	121*	1815*
5	Ukum	10	9	107	1605
6	Vandeikya	10	10	129	1935
7	Kwande	9	6	76	1140
8	Buruku	10	9	103*	1545*
9	Gwer-East	9	6	75	1125
10	Gwer-West	10	2	25	375
11	Gboko	9	5	53	795
12	Tarka	10	6	80	1200
13	Guma	9	5	55	825
14	Makurdi	10	8	99	1485
15	Apa	10	8	96	1440
16	Ogbadibo	10	9	117	1755
17	Otukpo	10	10	137*	2055*
18	Agatu	6	6	60	900
19	Okpokwu	10	10	137	2055
20	Oju	10	10	138	2070

Source: Benue State Fadama Coordinating Office (2013a)

*Figure from selected LGAs making up total population for the study

Given that the average number of members (household) in an FUG was fifteen (Benue State Fadama Coordinating Office, 2013a) the total population for this study from the three selected LGAs was 5,415 members (households) and 361 FUGs see Table 3.1.

3.5 Sampling Procedure

Stratified and purposive sampling techniques were used to draw out the sample. The population was stratified into six (6) major Economic Interest Groups; Crop, Agro-processing, Livestock, Fisheries, Marketing and Agro-forestry. Four (4) of these major Economic Interest Groups (EIGs) Crop, Agro-processing, Livestock and Fisheries were purposely selected from three (3) LGAs; Logo, Buruku and Otukpo. The other EIGs (Marketing and Agro-forestry) were not selected because they are scantly represented in the LGAs (see Appendix III). From each of the four stratums, farmers were randomly selected using simple random sampling to make up the sample. Also, from the crop EIG, farmers cultivating their individual farms from Fadama III project were randomly selected using simple random sampling and grouped into yam, cassava, rice and groundnut producers.

3.6 Sample Size

To determine the sample size, the study adapted the Gaussian distribution formula (http://www.netquest.com/blog/en/tag/sample-size-calculator). The Gaussian distribution also known as the normal distribution was chosen because it belongs to the family of stable distribution and the assumption of normality underlies many statistical tests such as the t-test, Analysis of Variance (ANOVA) as well as linear and non-linear regression used in this study. The formula is stated as:

$$n = \frac{N.Z^2.p.(1-p)}{(N-1).e^2 + Z^2.p.(1-p)} \quad \text{---}3.1$$

Where:

n = sample size to be calculated;

N = the population size;

Z = the desired confidence level (Confidence level 95% -> Z=1.96);

e = maximum margin of error (5%); and

p = the population proportion (.50 this is assumed to provide the maximum sample size).

Using the formula on equation (3.1) and a total population of 361 Fadama User Groups, the sample size for the FUGs was calculated as:

$$\frac{361X3.8416X0.25}{360X0.0025+3.8416X0.25}=186$$

Using the approach of proportionate stratification (equation 3.2) where the sample size of each stratum is proportionate to the population size of the stratum (StatTrek, 2014), the sample sizes of the four EIGs (see Appendix III) was determined using the formula:

$$n_h = (N_h / N)\, n \quad \text{---}3.2$$

where:

n_h = the sample size for stratum h;

N_h = the population size for stratum h;

N = total population size; and

n = total sample size.

The result of the sample size allocated to each stratum of EIG was 112 for crop, 35 for livestock, 18 for agro-processing and 8 for fisheries. In order to carry out individual group analysis, the sample size for livestock, agro-processing and fisheries EIGs was increased to include all the EIGs. This gave a sample size of 229 EIGs.

For the individual crop farmer, using the formula on equation (3.1), a total population of 5415 member household and an average of 15 member (household) in an FUG, the sample sizes was calculated as:

$$\frac{5415X3.8416X0.25}{5414X0.0025+3.8416X0.25}=359$$

This sample size was also increased to four hundred (400) to make room for more coverage thus; the total sample size for both Fadama User Groups and Individual farmers was 229+400 = 629.

3.7 Method of Data Collection

Data for the study was mainly collected from primary sources with the aid of well-structured questionnaire. This elicited responses in line with the specific objectives of the study. Secondary data was obtained from secondary sources like the Benue State Fadama Coordinating office, Books, Internet and Library sources.

3.8 Method of Data Analysis

Data for the study was analyzed using both descriptive and inferential statistical tools.

i. Descriptive tools such as percentages and frequency distribution were used to describe and summarize objectives i and iii. The t-test was used to analyze objective ii and the Analysis of Variance (ANOVA) was used to analyze objective ii and vi. This was done to check for significant differences among the outcomes. The variables serving as indicators of sustainability were normalized to obtain the sustainability index to achieve objective vii.

ii. The Logit regression analysis was used in analyzing objectives iv; while the Stochastic Frontier Production Function was used to analyze objective v. The statistics of the stochastic frontier production function models were obtained using maximum likelihood estimation method.

The t-test was conducted to check for differences between baseline income and beneficiaries' income. The two samples test of means with unequal standard deviation formula was given as:

$$t = \frac{x_1 - x_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad \text{----------} \quad 3.3$$

where:

x_1 = mean income of beneficiaries;

x_2 = baseline mean income;

s_1^2= variance of beneficiaries income;

s_2^2= variance of baseline income;

n_1= sample size of beneficiaries; and

n_2= sample size of baseline data;

The effect of inflation affecting the value of money at end-line when comparing with baseline income was not considered, this is because the inflation rate reported by CBN (2014) which was 13.8% when the baseline income was computed fell to 9.2% as at June 2015 according to CBN's (2015) report when the end-line income was computed. Thus inflation did not have negative effect on the value of the beneficiaries' income; besides, information in the baseline report did not indicate real baseline income.

3.8.1 Theoretical Framework and Model Specification

This study used a synthesis of theories. The adoption behaviour model proposes that the adoption of improved technology is expected to improve productivity and increase incomes of Fadama III beneficiaries. The study used the Cobb-Douglas Stochastic Frontier production function to analyze the productivity of farmers and logit regression to examine the adoption of beneficiaries which is largely influenced by socio-economic and environmental factors. These factors are influenced by inhibiting and driving forces which cause behavioural changes, thus affecting the adoption of improved technology. The SAFE model defined the indicators that were used to assess the progress of Fadama III beneficiaries towards sustainability.

3.8.1.1The Cobb-Douglas Stochastic Frontier Production Function

The Stochastic Frontier production function was presented showing equations that link the output of the various agricultural activities by the Fadama beneficiaries to resources (inputs) on the one hand and the output of the Fadama beneficiaries to inefficiency model on the other hand. In the inefficiency model, inefficiency effects were linked with the factors that affect the agricultural sustainability of the Fadama project. The efficiency of production was specified by the Cobb-Douglas Frontier Production Function. The function isolates factors responsible for inefficiency (Ogundari and Ojo, 2006).

The Stochastic Frontier production function as presented by Coelli (1995) is restated from 2.1 as:

$$Y_i = f(X_i, \beta + V_i - U_i) \text{ --- } 3.4$$

Variables are as earlier defined.

The inefficiency frontier model is presented as:

$$Y_i = \exp \phi_i, \beta + (V_i - U_i) \text{ --- } 3.5$$

where:

ϕ_i = vector of production input of the ith farm

β= vector of unknown parameters to be estimated

V_i = random variable which is assumed to be normally distributed with zero mean and constant variance σ^2 and independent of the U_i.

U_i = non-negative random variable which are associated with technical inefficiency and are assumed to be independently distributed of the V_i. They are obtained by truncation (at zero) of the normal distribution.

3.8.1.1.1 Cobb-Douglas Stochastic Frontier Production Function for Crop EIG

The Cobb-Douglas Stochastic Frontier Production Function for Crop EIG is explicitly expressed as: $LnY_i = \beta_0 + \beta_i \ln X_i ---+V_i - U_i$ -- 3.6

where:

ln = natural logarithm

β_o = constant

Y_i = output of the i^{th} beneficiary in kg

$X_i = X_1 - X_5$

X_1 = farm size (ha)

X_2 = seed/seedling (kg)

X_3 = fertilizer (kg)

X_4= Agrochemical (litre)

X_5 = labour (man days)

β_s = parameter to be estimated

V_1 = random error that is assumed to be normally distributed with zero mean and constant variance $(0, \delta^2)$

U_i = technical inefficiency effect independent of V_i was modeled in terms of the factors that are assumed to affect the efficiency of production. Such factors are related to the socio-economic attributes of the respondents. The determinant of technical inefficiency is defined as

$U_i = Z_0 + \phi_i Z_i + w_i$ -- 3.7

where:

U_i = technical inefficiency;

Z_o = constant.

$Z_i = Z_1 - Z_5$

Z_1 = Advisory services (number of advisory/ extension services attended);

Z_2 = Savings rate (1= If beneficiaries save up to 10% of income from Fadama crop farming, 0 = if otherwise);

Z_3 = Timeliness in provision of finance (1 if funds were given to the beneficiaries before the planting season, 0 if otherwise);

Z_4 = Provision of inputs (1 if input is provided by Fadama III, 0 if otherwise);

Z_5 = Adoption of technology (1 if extent of adoption is over 50%, 0 if otherwise);

ϕ_i = parameters to be estimated; and

w_i = Disturbance term

3.8.1.1.2 Cobb-Douglas Stochastic Frontier Production Function for Livestock EIG

The Cobb-Douglas Stochastic Frontier Production Function for Livestock EIG is explicitly expressed as: $Ln\mathrm{Y}_i = \ln\beta_0 + \beta_i \ln\lambda_i - - - + V_i - U_i$ -- 3.8

Where:

Y_i = output (kg);

Ln = natural logarithm;

β_0 = constant.

$\lambda_i = \lambda_1 - \lambda_4$

λ_1 = herd size (number);

λ_2 = feeds (kg);

λ_3 = Group labour (man days);

λ_4 = hired labour (man days); and

β_s = Parameters to be estimated.

The inefficiency of production is expressed as:

$U_i = \phi_0 + \phi_i \Omega_i + w_i$ -- 3.9

Where:

U_i = technical inefficiency;

ϕ_0 = constant.

$\Omega_i = \Omega_1 - \Omega_4$

Ω_1 = Advisory services (number of advisory/ extension services attended);

Ω_2 = Savings rate (1 = If beneficiaries save up to 10% of income from Fadama III crop farming, 0 = if otherwise);

Ω_3 = Timeliness in provision of finance (1 if funds were given to the beneficiaries before raising livestock, 0 if otherwise);

Ω_4 = Adoption of technology (1 if extent of adoption is over 50%, 0 if otherwise); and

w_i = Disturbance term

3.8.1.1.3 Cobb-Douglas Stochastic Frontier Production Function for Agro-processing EIG

The Cobb-Douglas Stochastic Frontier Production Function for agro-processing EIG is explicitly expressed as: $Ln\mathrm{Y}_i = \ln \beta_0 + \beta_i \ln \pi_i - - - + V_i - U_i$ -- 3.10

where:

Y_i = output in kg;

β_0 = constant.

$\pi_i = \pi_1 - \pi_4$

π_1 = quantity of products processed (kg);

π_2 = Quantity of petrol (litres);

π_3 = Quantity of firewood (kg);

π_4 = labour (man days); and

β_s = parameter to be estimated

The inefficiency of production is expressed as:

$$U_i = \phi_0 + \phi_i \int_i + w_i \quad \text{-----} \quad 3.11$$

where:

U_i = technical inefficiency

ϕ_0 = constant

$\int_i = \int_1 - \int_4$

$\int_1$ = Advisory services (number of advisory/ extension services attended);

$\int_2$ = Savings rate (1 = If beneficiaries save up to 10% of income from Fadama crop farming, 0 if otherwise);

$\int_3$ = Timeliness in provision of finance (1 if funds were given to the beneficiaries during harvest of agricultural produce, 0 if otherwise);

$\int_4$ = Adoption of technology (1 if extent of adoption is over 50%, 0 if otherwise);

ϕ_i = parameters to be estimated; and

w_i = Disturbance term

3.8.1.2 The Logit Model

The socio-economic factors affecting the adoption of technology were analyzed using the logit regression analysis.

The implicit form of the logit model is specified as:

$$\ln(\frac{p}{1-p}) = y = a + \beta x + u \quad \text{-- 3.12}$$

Where y is an indicator variable equal to unity (1) if household extent of adoption of improved technology is greater than or equal to 50 per cent and 0 (zero) if household extent of adoption of improved technology is below 50 percent (adapted from Govereh, Jayne and Nyoro, 1999).

α = the intercept which is also the value of y when the value of all the other independent variables is zero.

χ = explanatory variables

β = coefficient which describes the size and nature of the contributions of X to Z. A positive β means that X increases the probability of the outcome; a negative β means that X decreases the probability; a large β means that the factors strongly influence the probability; while a near zero means that the X has little influence on Z.

u = the error term

The explicit form of the model is given as:

$$Z\,(0,1) = \log \frac{p}{1-p} = \beta_o + \beta_{ij} X_{ij} \ldots \beta_n X_n + \varepsilon_i \quad \text{-- 3.13}$$

The dependent variable Z = probability is of a dichotomous nature representing beneficiary's extent of adoption of technology. This is discriminating between those beneficiaries who have effectively adopted the improved technologies introduced by the Fadama Project, and those beneficiaries who have not effectively adopted. βo the intercept which is also the value of Z when the value of all the other independent variables are zero. βi= the coefficient which describes the size and the nature of the contributions of X to Z.

The extent of adoption of improved technology was measured using an index adopted from Nwaiwu et al. (2013) with some modifications and is given as:

$$T_A = \frac{N_{TA}}{N_{NA}} X 100 \quad \text{--} \ 3.14$$

where:

T_A= Extent of technology adopted;

N_{TA} = Number of technology adopted; and

T_{NA} = Total number of technology introduced.

3.8.1.2.1 Logit Model for Crop EIG

The specific form of the logit model for crop EIG is given as:

$$Z = TA = \beta_o + \beta_1 SAR + \beta_2 OKG + \beta_3 PRI + \beta_4 ACM + \beta_5 ADS + \beta_6 TMF + \beta_7 FMS + \beta_8 CTF + \beta_9 CTA + \beta_{10} CTSS + \mu --- 3.15$$

where:

SAR = savings rate (1 = If beneficiaries save up to 10% of income from Fadama crop farming, 0 if otherwise);

OKG = Output in kg;

PRI = provision of input (1 if input is provided by Fadama III, 0 if otherwise);

ACM = access to market (1 if beneficiaries have access to market, 0 if otherwise);

ADS= Advisory services (number of advisory/ extension services attended);

TMF = Timeliness of funds (1 if funds were given to the beneficiaries before the planting season, 0 if otherwise);

FMS = farm size (ha);

CTF = cost of fertilizer (₦);

CTA = cost of agrochemical (₦);

$CTSS$ = cost of seed/seedling (₦);

β_s = Parameter estimates; and

μ = the error term.

3.8.1.2.2 Logit Model for Livestock EIG

The specific form of the logit model for livestock EIG is given as:

$$Z = TA = \beta_o + \beta_1 HDS + \beta_2 OKG + \beta_3 ADS + \beta_4 CTF + \beta_5 ACM + \beta_6 TMF + \beta_7 SAR + \mu \quad ------- 3.16$$

where:

HDS = herd size (in number);

OKG = output (kg);

ADS = Advisory services (number of advisory/ extension services attended);

CTF = cost of feed (₦);

ACM = access to market (1 if beneficiaries have access to market, 0 if otherwise);

TMF = Timeliness of funds (1 if funds were given to the beneficiaries before raising livestock, 0 if otherwise);

SAR = savings rate (1 = If beneficiaries save up to 10% of income from Fadama livestock farming, 0 if otherwise);

β_s = Parameter estimates; and

μ = the error term.

3.8.1.2.3 Logit Model for Agro-processing EIG

The specific form of the logit model for agro-processing EIG is given as:

$$Z = TA = \beta_o + \beta_1 CTFW + \beta_2 SAR + \beta_3 OKG + \beta_4 ADS + \beta_5 CTP + \beta_6 ACM + \beta_7 TMF + \mu \quad --------3.17$$

where:

CTFW = cost of firewood (₦);

SAR = savings rate (1 = If beneficiaries save up to 10% of income from Fadama III agro-processing project, 0 if otherwise);

OKG = output (kg);

ADS = Advisory services (number of advisory/ extension services attended);

CTP= cost of petrol (₦);

ACM = access to market (1 if beneficiaries have access to market, 0 if otherwise);

TMF = Timeliness of funds (1 if funds were given to the beneficiaries before harvest of produce, if 0 otherwise);

β_s = Parameter estimates; and

μ = the error term.

3.8.2 Analysis of Project implementation across Project Components

Implementation of the project across the project components was analyzed by examining the project expected outcome and indicator as presented in Table 3.2.

Table 3.2: Expected Outcomes of Fadama III components and their Indicators

Outcomes	Indicators
Component 1. capacity building communications and information support	1. By mid-term review, 75% of participating communities have local development plans

(CBCI) 1. Increased participation of Fadama users in the management of Fadama resources.	(LDPs) develop through a participatory process.
2. Strengthened capacity of FUGs and FCAs in managing development projects	2. By end of project 75% of FUGs have fully (100%) implemented approved LDPs.
Component 2: small–scale community–owned infrastructure (SCI) 1. Improved access of communities to productive rural infrastructure that generates shared economic or environmental benefits	1. 40% of participating Fadama communities have at least one productive rural infrastructure constructed/rehabilitated(disaggregated by feeder roads, culverts/small bridges
Component 3: Advisory services and input support (ASIS) 1. increased utilization of rural advisory services	1. 30% increase in the number of Fadama users procuring rural advisory services in the participating communities.
2. Increased access to agricultural inputs.	2. 50% increase in the number of Fadama farmers with access to agricultural inputs (disaggregated by gender and vulnerable groups)
Component 4: support to ADPs and sponsored research 1. Strengthened capacity of ADPs to provide extension services to Fadama farmers.	1. 30% increase in the number of Fadama farmers receiving extension services from ADPs (disaggregated by gender, vulnerable groups)
2. Strengthened link between Fadama users and research institutions	2. 20% increase in new technology adopted in Fadama communities
Component 5: Asset Acquisition and market systems development 1.Increased value added to agricultural products	1. 20% increase in income from sales of value added agricultural products.

Source: World Bank (2008)

The baseline report, the indicators and the target values across the project components (see Appendix II) were used as a basis for analyzing the extent of implementation of the project in Benue State. The outcomes expected across the project components and their indicators are as presented in Table 3.2. Data sourced from Fadama III beneficiaries and their Local Development Plans were compared with the baseline data and target values (see Appendix II) to ascertain if the project was fully implemented.

3.8.3 Analysis of Project Sustainability

The Sustainability Assessment of Farming and the Environment (SAFE) framework developed by Van Cauwenbergh *et al.* (2006) uses principles, criteria and indicators to develop and measure the level of sustainability of farmers. It has been used by Ameen *et al.* (2011) in Spain, Westers (2012) in Sri Lanka and Kleemann (2012) in Africa. Therefore this research work keys into these analysis by using the SAFE framework to analyze the sustainability of Fadama III farmers in Benue State. The hierarchical framework which is based on principles, criteria and indicators is presented in Table 3.3.

Table 3.3: SAFE Model for the Construction of Economic Indicators of Sustainability

Principle	Criteria	Indicator

Maximize economic viability	maximize farm income	-farm income
		-non-farm income
		-farm size
		-savings
Efficient Agricultural activities		-technical efficiency
		-economic efficiency
Optimize knowledge of the industry		-farming experience
		-number of extension contacts
		-extent of adoption of technology

Adapted from Van Cauwenbergh *et al.*, (2006) and Westers, (2012)

The indicators were measured directly except for efficiency estimation which was measured using the stochastic frontier production function and the extent of adoption of technology was measured using equation 3.14. The variables in the analysis were normalized to rescale the data to the unit interval and even out different in units of the indicator variables. The formula is given as:

$$\delta_i = \frac{v_i - \min_A}{\max_A - \min_A}(new\max_A - new\min_A) + new\min_A \quad \text{---------------------------------} \ 3.18$$

where:

δ_i = sustainability Index (economic);

v_i = indicator variable(eg. income);

min_A = minimum Value of the variable;

max_A = maximum value of the variable;

$newmax_A$ = 1 most sustainable; and

$newmin_A = 0$ not sustainable.

The sustainability index ranged from zero (0) not sustainable to one (1) highly sustainable. Terano, Mohamed, Shamsudin and Abd Latif, (2013) assigned five discrete sustainability categories, with the following range of index values:

Quite sustainable>70.0;

Somewhat sustainable: 60.1-70.0;

Intermediate sustainable: 50.1-60.0;

Possibly unsustainable: 40.1-50.0; and

Possibly quite unsustainable: < 40.0.

The sustainability index for the study was calculated across the Economic Interest Groups (EIGs) and individual crop farmers to ascertain the category of sustainability of their productive activities.

3.8.4 Distribution and Retrieval of Questionnaire

A total of 629 Economic Interest Groups and Fadama individual crop farmers were sampled and administered questionnaire from three Local Government Areas; Logo, Buruku and Otukpo. Out of this, only 554 questionnaires representing 88% were returned. The others were either not returned or not properly filled and therefore were invalid. The distribution of the retrieved questionnaires is presented in Table 3.4.

Table 3.4: Distribution of Retrieved Questionnaire across Economic Interest Groups and Individual Crop Farmers

Economic Interest Groups	Frequency	Individual crop farmers	Frequency
Livestock	41	Yam	120
Agro-processing	35	Cassava	92
Crop	65	Rice	105
Fisheries	15	Groundnut	63
		Maize	8
		Soyabeans	10
Total	156		398

Source: Field Survey, 2015

Therefore, data analysis in the study is based on 554 questionnaire correctly filled, out of which 156 were from the Fadama User Group segregated into 41 livestock, 35 agro-processing, 65 crop and 15 fisheries. The remaining 398 were from the individual crop farmers segregated into 120 yam, 92 cassava, 105 rice and 63 groundnut, 8 maize and 10 soya beans. Fish EIG, Livestock EIG and Agro-processing EIG did not have individual farms. While descriptive statistics was on all segments, inferential statistics like the logit regression analysis and the stochastic frontier analysis was only on EIGs and individual farmers with frequency more than 30 to allow for normality (the central limit theorem).

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS OF RESULTS

4.1 Socio-Economic Characteristic of Respondents

The results in Table 4.1 show the socio-economic characteristics of the respondents. From the table, 80.3% of Fadama III beneficiaries were male while 19.7% were female. This shows that there are more male beneficiaries than female beneficiaries. The distribution of respondents according to age shows that 4.9% of the respondents were aged between 23 and 32 years, about 22.2% of the respondents were aged between 33 and 42 years, and those aged between 43 and 52 constituted 39%. Respondents that were aged between 53 and 62 were 22.3%, and those whose ages were 63 and above accounted for 11.6%. The mean age of the respondent was 49.2.

Table 4.1: Summary Statistics of Socio-economic Characteristics of Fadama III Beneficiaries in Benue State

Variable	Frequency	Percentage	Minimum	Maximum	Mean	Standard deviation
Membership Size			11	25	23.45	2.79
11-15	15	2.7				
16-20	112	29.2				
21-25	427	68.1				
Age			23	89	49.15	10.94
23-32	27	4.9				
33-42	123	22.2				
43-52	216	39				
53-62	124	22.3				
63-above	64	11.6				
Sex						
Male	445	80.3				
Female	109	19.7				
Primary occupation						
Farming	487	87.9				
Civil service	53	9.6				
Trading	14	2.5				
Educational attainment						
No formal education	78	14.1				
Primary	144	26.0				
Secondary	230	41.5				
ND/NCE	87	15.7				
HND,Degree, Masters	15	2.7				

Source: Field Survey, 2015

This finding agrees with that of Ojowu (2014) who reported that respondents in their study area in Benue State had a mean age of 47.1 years and suggested that the beneficiaries active age will enable them participate actively in Fadama supported economic activities. The result in Table 4.2

also shows that 2.7% of the beneficiaries of Fadama III project in Benue State had membership size of their cooperative between 11and 15, 29.2% had membership size of 16 to 20 persons while as high as 68.1% had membership size of 21 to 25 persons. The mean membership size was approximately 24 members. The result also showed that for 87.9% of Fadama III beneficiaries in Benue State, farming was their primary occupation, 9.6% were civil servant and 2.5% were into trading. This study agrees with World Bank's (2013) report that 70% of Nigerians are farmers. The predominance of farmers in this area explains why Benue State is titled the "Food Basket" of the nation. The result also shows that 14.1% of the household heads had no formal education, 26% had primary education, 41.5% had secondary education, 15.7% had National Certificate of Education (NCE)/Ordinary National Diploma (OND) and only 2.7 % had Degree/Higher National Diploma (HND). Thus, 85.9% had some form of formal education. Experience of formal education can give an unparallel advantage to the people of the area in terms of quick understanding of innovative programmes.

4.2 Analysis of Implementation of Fadama III Project across the Components

4.2.1 Component 1: Social Capital Formation and Local Development Plans

The result in Table 4.2 shows that all the respondents in livestock, agro-processing and fisheries group participated in planning, selecting and developing their local development plans. This may be so because only the group leaders in these FUGS were contacted for information, as such, they led other members in taking the decisions about their local development plans.

Table 4.2: Social Capital Formation through participation among Fadama III Economic Interest Groups

	Fadama III Economic Interest Groups Type			
	Crop (n=463*)	Livestock (n=41)	Agro-processing	Fisheries (n=15)

Participation	(n=35)							
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Planning activities	454	98.06	41	100	35	100	15	100
Selecting enterprises	443	95.68	41	100	35	100	15	100
Developing LDP	362	78.19	41	100	35	100	15	100

Source: Field Survey, 2015 * crop, n=463 comprises addition of crop FUG and Individual crop farmers

The result shows that participation in planning, selecting and developing LDPs was 98.06%, 95.68% and 78.19% respectively for crop EIG. This is because respondents in the crop EIG included group leaders and individual crop farmers who did not participate in some activities. On the whole, over 75% of Fadama user groups and individual crop farmers participated in planning, selecting and developing their local development plans (LDP). Participation or collective action is a measure of social capital. It enhances group performance, trust and solidarity as a result of interaction among group members.

4.2.1.1 FUGs with Fully Implemented Approved project in Local Development Plans

The number of FUGs with fully implemented approved Local Development Plans (LDPs) is presented in Table 4.3.

Table 4.3: FUGs with Fully Implemented Approved Local Development Plans

FUGs	No. approved LDPs	No. of projects approved in LDPs (3 per LDP)	No. of implemented project in LDP (1 per LDP)

Crop	65	195	65
Livestock	41	123	41
Agro-processing	35	105	35
Fisheries	15	45	15

Source: Field Survey, 2015

It was found that the entire 156 FUG have fully approved LDPs. In every LDPs approved, three (3) projects were slated for implementation, of this three projects, only one was implemented. This means only 33.33% of the projects approved were implemented. This level of implementation is below average. Implementation is largely a function of funding. The implication is that the FUGs were able to access funds for only 33.33% of projects meant to be implemented.

Given the low implementation of projects in the LDPs, the contribution of counterpart funds by Benue State Government and the participating Local Government Areas was analyzed and presented.

Table 4.4: State Government Counterpart funds Contributions 2009-2013

S/N	Year	Budget (₦)	Amount Paid (₦)	Balance (₦)
1	2009	56,400,000.00	56,400,000.00	-
2	2010	56,400,000.00	8,600,000.00	47,800,000.00
3	2011	56,400,000.00	-	56,400,000.00
4	2012	56,400,000.00	-	56,400,000.00
5	2013	56,400,000.00	-	56,400,000.00
Total		282,000,000.00	65,000,000.00	217,000,000.00

Source: Benue State Fadama III Coordinating Office (2013b)

Information in Table 4.4 shows that out of two hundred and eighty two million naira (₦282,000,000.00) budgeted for Fadama III project as State Government counterpart fund, only sixty five million naira (₦65,000,000.00) representing 23% was paid by the State Government leaving a shortfall of two hundred and seventeen million naira (₦217,000,000.00) representing 77% of the budget. This shortfall in counterpart funds from the State Government had negative impact on project implementation as only one out of the three projects earmarked for implementation in the local development plans was implemented.

An analysis of the counterpart funds provided by local government is also presented in Table 4.6. The result shows that Counterpart funds from Local Government were also not fully paid.

Table 4.5: Local Government Counterpart funds Contributions 2009-2013

S/N	Year	Budget (₦)	Amount Paid (₦)	Balance (₦)
1	2009	40,000,000.00	40,000,000.00	-
2	2010	40,000,000.00	40,000,000.00	-
3	2011	40,000,000.00	40,000,000.00	-
4	2012	40,000,000.00	-	40,000,000.00
5	2013	40,000,000.00	-	40,000,000.00
Total		200,000,000.00	120,000,000.00	80,000,000.00

Source: Benue State Fadama III Coordinating Office (2013b)

Out of two hundred million naira (₦200,000,000.00) budgeted for Fadama III project, only One hundred and twenty million naira (₦120,000,000.00) representing 60% of the budget was contributed by participating Local Governments, leaving a shortfall of eighty million naira (₦80,000,000.00) representing 40% of the budget. The inability to fully pay up counterpart funds by Local Government Areas also could have resulted in the partial implementation of the Fadama III project in Benue State.

A further analysis of counterpart funds shows that the International Devlopment Association (IDA) also did not fully pay up its counterpart funds; contributing 81% (see Appendix IV). This inability to fully pay up counterpart funds by IDA could have been as a result of the failure of

Benue State and her participating Local Governments' to pay their part of the funds. This has hampered the continuity of the Fadama III project termed Fadama III Additional Financing which is still ongoing in States like Niger, Bauchi, Enugu, Anambra, and Akwa-Ibom amongst others.

4.2.2 Component 2: Productive Rural (community based) Infrastructure

The FUGs in the study area under Fadama III acquired the following productive assets and equipments. They include knapsack sprayer, ground nut shelling machine, hoes, wheelbarrow, cutlasses, milling machines, storage equipments, and cassava processing machines. Others are feeders, rain coats, shovels, hooks and Nets. The results in Table 4.6 show that Knapsack sprayers were the dominant equipment acquired by crop FUG; over 95% of crop farmers acquired knapsack sprayers.

Table 4.6: Productive assets and Equipment acquired by Fadama III Beneficiaries across Fadama User Groups

	Fadama User Group Type			
Productive asset and	**Crop (n=65)**	**Livestock (n=41)**	**Agro-processing (n=35)**	**Fisheries (n=15)**

Equipment								
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Knapsack sprayer	62	95.38	0	0	0	0	0	0
Groundnut shelling	0	0	0	0	12	34.29	0	0
Drinkers	0	0	36	87.80	0	0	0	0
Hoe	59	90.77	0	0	0	0	0	0
Wheelbarrow	12	18.46	14	34.14	9	25.71	0	0
Cutlass	27	41.54	0	0	0	0	0	0
Milling machines			0	0	19	54.29	0	0
Feeders	0	0	38	92.68	0	0	0	0
Raincoat	6	9.23	0		0	0	0	0
Shovel	13	20	9	21.95	0	0	0	0
Hooks	0	0	0	0	0	0	8	53.33
Nets	0	0	0	0	0	0	6	40

Source: Field Survey, 2015 Frequency greater than the number is due to multiple responses

The dominance of knapsack sprayers shows that most FUG members are crop farmers. This agrees with Abu (2011b) who observed that labour for weeding in farm operations is scarce and costly, thus the use of chemicals to control weeds is widespread. The livestock group acquired more of feeders and drinkers while the agro-processing group acquired milling machines. The fisheries group dominated in hooks and nets. The zeros (0) in the table indicate that the group did not acquire that particular asset. The implement used by Fadama III beneficiaries in the study area shows that they are more of subsistence farming using traditional tools, thus the use of modern farming equipment such as tractors and harvesters should be encouraged for more bountiful harvest.

4.2.3 Component 3: Access to Advisory services and Inputs by Economic Interest Groups

4.2.3.1 Access to Rural advisory services by Fadama III Economic Interest Groups

Table 4.7 indicates that 80% of respondents involved in crop production and 80% in fisheries EIGs had access to rural advisory services. This was followed by 73.17% in the livestock group and 68.29% in agro-processing group.

Table 4.7: Access to rural advisory services by Fadama III Fadama User Group

Access to rural advisory services	Fadama User Group Type							
	Crop		Livestock		Agro-processing		Fisheries	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Access	52	80	30	73.17	28	68.29	12	80
No Access	13	20	11	26.83	7	31.71	4	20
Total	65	100	41	100	35	100	15	100

Source: Field Survey, 2015

The result shows that majority of the beneficiaries of Fadama III project were able to access advisory services meant to educate them on ways to participate actively in their economic activities.

4.2.3.2 Sources of Agricultural Inputs to Fadama III Crop Economic Interest Group

The major sources of agricultural inputs for Fadama III crop EIG are presented in Table 4.8. It is interesting to note that Fadama III was the major provider of improved seeds for the beneficiaries.

Table 4.8: Sources of agricultural inputs for Fadama III Crop Economic Interest Group

Agricultural input and sources	Frequency	%
Fertilizer		
Input traders	15	23.08

ADP	0	0
Fadama III	17	26.15
NGO/farmer group	0	0
Other farmers	1	2
Self	0	0
Open market	35	53.85
Improved seed		
Input traders	35	53.85
ADP	0	0
Fadama III	55	84.62
NGO/farmer group	0	0
Other farmers	11	16.92
Self	0	0
Open market	13	20
Agrochemical		
Input traders	53	81.54
ADP	0	0
Fadama III	8	12.31
NGO/farmer group	0	0
Other farmers	0	0
Self	0	0
Open market	45	69.23

Source: Field Survey, 2015 Frequency greater than the number is due to multiple responses

Fadama III was the source of improved seeds for about 84.62% of the beneficiaries but only 26.15% for fertilizer users. However, most beneficiaries sourced agrochemicals from open market (69.23%) and input traders (81.54%). Only 12.31% of the respondents got agrochemicals from Fadama. It was observed that the Agricultural Development Project (ADP) did not provide beneficiaries with any of the inputs; the reason was that they were to provide extension services where demonstrations on the application of the improved technology were needed. The high patronage for farm inputs from input traders and open market is a good indication that some

Fadama farmers are willing and able to buy farm inputs irrespective of project or government support.

Agricultural inputs, disaggregated by gender and vulnerable group are shown in Table 4.9. The disaggregation by gender showed that male farmers outnumber female farmers in terms of access to all the three identified agricultural inputs.

Table 4.9: Agricultural inputs accessed by Fadama III Crop EIG disaggregated by gender and vulnerable group

	Agricultural inputs					
Characteristics	**Fertilizer**		**Agro-chemicals**		**Seed**	
	Frequency	%	Frequency	%	Frequency	%
Gender						
Male	55	84.62	52	80	49	75.38
Female	10	15.38	13	20	16	24.62
Vulnerable group						
Aged	2	3.08	6	9.23	11	16.92
Widow	4	6.15	7	10.77	9	13.85
Unemployed youth	3	4.62	5	7.69	7	10.77

Source: Field survey, 2015

The female farmers' access to agricultural inputs was less than 50% for all the identified inputs; this is below the target value of 50% access as stipulated in the result monitoring framework (see Appendix II). This means that there is inequality of women's access to farm inputs even though they make enormous contributions to agricultural production in Benue State. Also, the vulnerable groups were able to access more of improved seed followed by agro-chemicals and less of fertilizer. This was as a result of the high cost of fertilizer compared to seeds and agro-chemicals.

The result in Table 4.10 shows that all the beneficiaries had access to grant resources for purchase of agricultural inputs, feeds and equipment. This shows that Fadama III beneficiaries in Benue state gained access to grant resources to purchase what was necessary for them to go into production of goods and services.

Table 4.10: Accessibility to grant resources for purchase of agricultural inputs, feeds and equipments by Fadama III Economic Interest Groups in Benue State

Access to grant resources	**Fadama III Economic Interest Groups Type**							
	Crop		**Livestock**		**Agro-processing**		**Fisheries**	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Access	65	100	41	100	35	100	15	100
No Access	0	0	0	0	0	0	0	0
Total	65	100	41	100	35	100	15	100

Source: Field Survey, 2015

Results in Table 4.11 show the timeliness on availability of grant resources for the purchase of agricultural inputs, feeds and equipment by beneficiaries.

Table 4.11: Timeliness of availability of grants for purchase of agricultural inputs by Fadama III Economic Interest Groups

	Economic Interest Groups Type							
	Crop		**Livestock**		**Agro-processing**		**Fisheries**	
Timeliness	Frequency	%	Frequency	%	Frequency	%	Frequency	%

Timely	13	20	17	41.46	12	34.29	5	33.33
Not timely	52	80	24	54.54	18	65.71	10	66.67
Total	65	100	41	100	30	100	15	100

Source: Field Survey, 2015

The result indicates that 80%, 54.54%, 65.71% and 66.67% of crop, livestock, agro-processing and fisheries FUGs respectively did not access grants to purchase their inputs, feeds and equipment when needed. Several reasons are responsible for the delay and these include, delay in accessing counterpart funds from other organs of government, delay in processing and poor linkage between service providers and FUGs.

4.2.4 Component 4: Support to Agricultural Development Projects and Sponsored Research

4.2.4.1 Provision of extension services by Agricultural Development Project

The Agricultural Development Project did provide extension services to Fadama III beneficiaries in Benue State, as such, these beneficiaries were able to adopt the technologies and the results are presented in Table 4.12

Table 4.12: Technologies adopted by Fadama User Groups

Technologies Available	Frequency	Percentage
Crop (n=65)		
Improved variety	51	78.46

Agro-chemical for weed control	57	87.69
Pest control	29	44.62
Irrigation Farming	0	0
Staking	10	15.38
Soil conservation	14	21.54
Record keeping	21	32.31
Transplanting	5	7.69
Fertilizer application	54	83.08
Livestock (n=41)		
Improved livestock breeds	36	87.80
Improved livestock feeds	23	56.10
Silage and Hay making	5	12.20
Grass cutter breeding	0	0
Record keeping	18	43.90
Agro-processing (n=35)		
Use of machines for rice milling	9	25.71
Use of machines for grating cassava	15	42.86
Use of groundnut shelling machines	11	31.43
Hygienic drying method	18	51.43
Record keeping	23	65.71
Fisheries (n=15)		
Concrete fish pond	15	100
Feed formulation	12	80
Hatchery and fingerling production	5	33.33
Improved method of feeding	11	73.33
Improved method of treatment	7	46.67
Restocking of exploited water	13	86.67
Record keeping	9	60

Source: Field Survey, 2015, Frequency greater than the number is due to multiple responses

The result shows that 78.46 % of crop FUG adopted improved variety of crops, 7.69% adopted transplanting, 87.69% used agro-chemical for weed control and none of the beneficiaries assessed adopted irrigation farming. This is agrees with George, (2015) who reported that less than 1% of Nigerian agriculture is irrigated. In the livestock FUG, 87.80% adopted improved breeds, 56.10% adopted improved livestock feeds and none of the livestock FUG adopted grass cutter breeding. In the agro-processing FUG, 25.71% used machines for rice processing, 42.86% used machines for grating cassava and 66% adopted record keeping. In the fisheries FUG, all the beneficiaries constructed concrete fish ponds, 80% formulated their feeds and 33.33% were into hatchery and fingerling production. This is over 20% target value stipulated in result monitoring framework. Thus beneficiaries of Fadama III in Benue State adopted improved technology in their productive activities.

4.2.5 Component 5: Asset Acquisition for Fadama User Groups

4.2.5.1 Value Additions to Agricultural Commodities by Fadama III Agro-processing EIG

The value additions to agricultural commodities produced by Fadama III agro-processing EIG and presented in Table 4.13. The commodities include rice processing into milled rice, cassava processing into chips, Garri and Akpu and groundnut shelling. It was observed that most farmers in Benue State often sell their farm produce in the primary form without being processed (adding value) and this account for the reason why they are poor and vulnerable due to the post harvest losses they encounter.

Table 4.13: Percentage Increase in Income of Agricultural Commodities as a result of Value-addition.

Commodity and unit cost (₦)	Processing cost (₦)	Processed commodity and unit cost (₦)	Percentage increase (%)

1 wheelbarrow of cassava tubers costs 500	1300	1 basin of Garri cost 3,500	48.57
1 wheelbarrow of cassava tubers costs 500	500	1 bag of 70kg Cassava chips 2500	60
1 bag of paddy rice cost 7,000	2000	4 tins of milled rice costing 14000	36
1 bag of groundnut cost 5000. 2.5 bags (12500) of groundnut gives 1 bag of shelled groundnut	1250	1 bag of shelled groundnut cost (100kg) 18000	24

Source: Field Survey, 2015

In a bid to alleviate rural poverty, processing activities are encouraged by Fadama III. This sometimes ranged from simple sun drying to changing the form of the commodity to enhance the storage life, ease transportation, packaging and to improve the nutritional content. Cassava can be processed into cassava chips, Akpu and garri. Cassava is a unique crop with immense potential to make farm families escape poverty trap and enhance food security. A wheel barrow full of cassava tubers is processed into one basin of garri. A full barrow load of cassava which is equivalent to a ridge of cassava on average costs ₦500 and a processed basin of garri on average cost ₦3,500. The processing technology is simple and basic. The cost elements in the processing are the labour utilized in the peeling costing ₦500 per wheel barrow; washing and grating cost ₦300 per wheel barrow and labour for frying cost ₦500 per wheel barrow. This brings the total processing cost to ₦1300. The processing of cassava from raw tubers to garri gives a 48.57% increase in income due to the advantage of value addition.

The second important item in which cassava tubers are processed into is cassava chip. The cost element is the labour in peeling which is ₦500 per wheel barrow. A full wheel barrow will produce one 70kg bag of cassava chips. A 70kg bag of cassava flour is sold for ₦2,500. The processing of cassava into cassava chips gives a 60% increase in income due to value addition. The percentage increase is higher for cassava chips than garri. The households prefer cassava being processed to garri because it is faster and can be done in a small space relative to the chips that takes a long time to sun-dry and a lot of space to dry.

Nigeria is currently the largest producer of cassava in the world with over 57million tons produced in 2013 (George, 2015). However, most of what is produced is consumed locally; and much of what is harvested is wasted due to production and post harvest inefficiencies. However, if these inefficiencies are addressed alongside the current development of improved varieties of the crop and the associated increased yield, Nigerian farmers could take advantage of the increase in income as a result of value addition as this will go a long way in reducing poverty.
Another important agricultural commodity of economic importance being processed by Fadama III agro-processing FUG members is rice. A 100kg bag of paddy rice cost ₦7,000. The cost of processing involves firewood ₦1,000, parboiling and drying ₦500 per bag and milling ₦500. A 100kg bag paddy rice can give 4 tins of milled rice and is a tin of rice which is equivalent to 22 kg is sold for ₦3,500, this gives an income of ₦14,000 and results to a 36% increase in income as a result of value addition.

Finally, Fadama III agro-processing FUG processed groundnuts. A bag of unshelled groundnut cost ₦5,000. The cost of processing is ₦500 to shell the groundnut, two and half bags of unshelled groundnut gives one 100kg bag of shelled groundnut. A bag of shelled groundnut is sold for ₦18,000 and this result to 24% increase in income as a result of value addition. On the whole, the percentage increase in income of agro-processing FUG was more than 20% for all the commodities processed; this means that Fadama III agro-processing farmers met the target value for increase in income in the result monitoring framework (see Appendix II) as a result of value addition.

4.3 Analysis of Income of Fadama III Beneficiaries in Benue State

4.3.1 Income Distribution of Fadama III Beneficiaries across the Economic Interest Groups

Information on the annual income of Fadama III beneficiaries across the EIG's was obtained and is presented in Table 4.14.

Table 4.14: Income Distribution of Fadama III Beneficiaries across the Economic Interest Groups in Benue State

Annual Income	**Livestock**		**Agro-processing**		**Crop**		**Fisheries**	
Range(₦)	F	%	F	%	F	%	F	%
Below 100,000	0	0	0	0	8	12.31	0	0
100,000-200,000	0	0	1	2.86	11	16.92	0	0
201,000-300,000	4	9.76	4	11.43	21	32.31	1	6.25
301,000-400,000	5	12.20	1	2.86	12	18.46	0	0
401,000-500,000	11	26.83	12	34.29	5	7.69	0	0
501,000 and above	21	51.22	17	48.57	8	12.31	14	93.75
Total	**41**	**100**	**35**	**100**	**65**	**100**	**15**	**100**

Source: Field Survey, 2015

The distribution of income reveals that 90.25%, 85.72% and 93.75% of livestock, agro-processing and Fish EIG's respectively have average income of over ₦300,000 while in the crop EIGs only 38.46% have average income of over ₦300,000. This shows that the other groups agro-processing, livestock and fisheries had higher income than the crop EIGs. The reason for this could be the seasonal nature of crop farming in Benue State wereas other farming activities like agro-processing, livestock and fisheries could have a turnover of up to four (4) production cycles in a year. This result agrees with Umeh (2011), whose result had crop EIG with the least income lower than agro-processing, livestock and fisheries EIGs.

4.3.1.1 Differences in Income Level across Fadama III Economic Interest Groups

To test for differences in the income of Fadama III beneficiaries across the EIG, the Analysis of Variance was used and the result is presented in Table 4.15

Table 4.15: ANOVA on Difference in Income level across Economic Interest Groups

Method	Df	Value	Probability
Anova F-test	(3, 152)	26.49399	0.0000
Welch F-test*	(3, 50.3331)	25.81661	0.0000

Category Statistics

Variable	Count	Mean	Std.Dev.	Std. Err. of Mean
AGROANNINC	35	501657.1	221613.6	37459.53
CROPANNINC	65	362184.6	181234.7	22479.40
LIVANNINC	41	579161.0	286300.4	44712.61
FISHANNINC	15	722941.5	220164.2	56846.14
All	156	541486.1	275575.8	22063.72

Source: Author's computation using E-views

Information from Table 4.15 shows the mean income of ₦501, 657.1, ₦362, 184.6, ₦579,161.0 and ₦722,941.5 for agro-processing, crop, livestock and fisheries EIG respectively. The Analysis of variance F-test value of 26.49 with a probability value of 0.00 shows that the difference in income is significant at 1% level. The Welch F-test is used when the assumption of homogeneity of variance is violated; it shows an F-test value of 25.82 with a probability value of 0.00, meaning that the difference in income is significant at 1% level. This indicates that the difference in income among the Fadama user groups is not by chance, fisheries FUGs are doing better in their productive activities and had more income than livestock FUGs and agro-processing FUGs, while crop FUGs are trailing behind livestock, fisheries and agro-processing FUGs.

4.3.2 Income Distribution of Fadama III Individual Crop Farmers in Benue State

Information on the average annual income of Fadama III Individual Crop Farmers was obtained and is presented in Table 4.16.

Table 4.16: Income Distribution of Fadama III Individual Crop Farmers

Annual Income	Cassava		Yam		Rice		Groundnut	
Range (₦)	F	%	F	%	F	%	F	%
Below 100,000	16	17.39	11	9.17	27	25.71	2	3.17
100,000-200,000	23	25	47	39.17	37	35.24	3	4.71
201,000-300,000	25	27.17	18	15	30	28.57	26	41.27
301,000-400,000	18	19.57	25	20.83	7	6.67	20	31.75
401,000-500,000	9	9.78	12	10	4	3.81	1	1.59
501,000 and above	1	1.09	7	5.83	0	0	0	0
Total	**92**	**100**	**120**	**100**	**105**	**100**	**63**	**100**

Source: Field Survey, 2015

The distribution of income revealed that 30.44%, 36.66% and 33.34% of cassava, yam, and groundnut individual crop farmers respectively have an average income of over ₦300,000, while in the rice individual crop farmers category, only 10.48% have average income of over ₦300,000. In this case, yam, cassava and groundnut farmers have done better than their rice counterpart.

4.3.2.1 Differences in Income Level across Fadama III Individual Crop Farmers

To test for difference in the income of Fadama III beneficiaries across the EIGs, the Analysis of Variance was used and the result is presented in Table 4.17.

Table 4.17: ANOVA on Difference in Income level of Fadama III Individual Crop Farmers

Method	Df	Value	Probability
Anova F-test	(3, 376)	3.765365	0.0110
Welch F-test*	(3, 205.387)	7.382290	0.0001

Category Statistics

Variable	Count	Mean	Std.Dev.	Std. Err. of Mean
YAMANNINC	120	250216.7	139251.6	12711.87
CASANNINC	92	248304.3	147270.5	15354.01
RICEANNINC	105	189388.9	134304.6	13106.79
GNUTANNINC	63	220314.3	65105.09	8202.471
All	380	231406.6	132090.8	6776.116

Source: Author's computation using E-views

Table 4.17 shows the mean annual income of ₦250,216.7, ₦248,304.3, ₦189,388.9 and ₦220,314.3 for yam, cassava, rice and groundnut farmers respectively. The Analysis of variance F-test value of 3.77 with a probability value of 0.01 shows that the difference in income is significant at 5% level. The Welch F-test is used when the assumption of homogeinity of variance is violated; it shows an F-test value of 7.38 with a probability value of 0.00, meaning that the difference in income is significant at 1% level. This indicates that the difference in income among the individual crop farmers is not by chance, yam farmers had more income than cassava farmers, and groundnut farmers are doing better in their productive activities than rice farmer.

To test hypothesis two which stated that Fadama III project has not increased the income of beneficiaries from baseline income, the t-test was used. The average income for Fadama III individual farmers was used to compare with household income at baseline. Using the values from Table 4.17:

$x_1 = 231406.6$, $s_1^2 = 17447768100$, n = 380 and

$x_2 = 32984$, $s_2^2 = 221652544$, n = 314 from baseline data (Abu, 2011a)

The calculated t value of 26.48 was greater than the tabulated value of 2.576 at 1% level of significance. Consequently the null hypothesis was rejected implying that Fadama III project has significantly increased the income of beneficiaries from baseline income. The baseline average household income of ₦32,984 increased by 14.25 per cent to ₦231,406 at the end of the project.

4.4 Analysis of Savings of Fadama III Beneficiaries in Benue State

4.4.1 Savings Rate of Fadama III Economic Interest Group in Benue State

Information on the savings rate of Fadama III EIG's was collected and presented in Table 4.18.

Table 4.18: Savings Rate of Fadama III Economic Interest Group in Benue State

	Livestock		**Agro-processing**		**Crop**		**Fisheries**	
Savings Rate	F	%	F	%	F	%	F	%
Below 10 percent	27	65.85	24	68.57	46	70.77	11	73.33
Above 10 percent	14	34.15	11	31.43	19	29.23	4	26.67
Total	**41**	**100**	**35**	**100**	**65**	**100**	**15**	**100**

Source: Field Survey, 2015

The result shows that 65.85%, 68.57%, 70.77% and 73.33% of livestock, agro-processing, crop and fisheries EIG respectively saved below 10% of annual income from their productive activities. These bring to average 69.53 % of Fadama III EIG saving below 10%. On the other hand, 34.15%, 31.43%, 29.23% and 26.67% of livestock, agro-processing, crop and fisheries EIG respectively saved above 10% of annual income from their productive activities. These bring to average 30.37 % of Fadama III EIG saving above 10%. This shows that almost 70% of Fadama III EIGs did not save much of their incomes as expected by the project. The inability to save has much effect on the sustainability of the Fadama III project as it is expected that savings will be used to purchase advisory services, inputs and even machines/equipments that are necessary for production to continue. The inadequate savings means that the project may close out if money is not available to continue production, since income is key to any productive activity.

4.4.2 Savings Rate of Fadama III Individual Crop Farmers in Benue State

Information on the savings rate of Fadama III individual crop farmers was collected and presented in Table 4.19.

Table 4.19: Savings Rate of Fadama III Individual Crop Farmers in Benue State

	Cassava		Yam		Rice		Groundnut	
Savings Rate	F	%	F	%	F	%	F	%
Below 10 percent	68	73.91	86	71.67	82	78.10	46	73.02
Above 10 percent	24	26.09	34	28.33	23	21.90	17	26.98
Total	**92**	**100**	**120**	**100**	**105**	**100**	**63**	**100**

Source: Field Survey, 2015

The result shows that 73.91%, 71.67%, 78.10% and 73.02% of cassava, yam, rice and groundnut individual crop farmers respectively saved below 10% of annual income from their productive activities. These bring to average 74.18 % of Fadama III individual crop farmers saving below 10%. On the other hand, 26.09%, 28.33%, 21.90% and 26.98% of cassava, yam, rice and groundnut individual crop farmers respectively saved above 10% of annual income from their productive activities. These bring to average 25.82 % of Fadama III EIG saving above 10%. On the whole, the savings rate was generally poor among Fadama III beneficiaries. This shows that the savings made by Fadama III beneficiaries in Benue State are not sustainable. One of the reasons given for the little savings was the absence of Deposit Money Banks in two (2) of the study areas (Buruku and Logo), also inadequate income from enterprises was given as the reason for poor savings. The inadequate income from enterprises could be as a result of failure of the project to release money on time to the beneficiaries in order to enable them carry out their productive activities. Thus, the factors limiting savings of Fadama III beneficiaries was analyzed and presented.

4.4.3 Factors Limiting Saving of Fadama III Economic Interest Group

The factors limiting savings of Fadama III EIG was analyzed and the result is presented on Table 4.20.

Table 4.20: Factors Limiting Savings of Fadama III Economic Interest Groups

Factors Limiting Savings	Economic Interest Group Type							
	Livestock		Agro-processing		Crop		Fisheries	
	F	%	F	%	F	%	F	%
Inadequate Income	26	63	19	61	38	58	4	27
Responsibilities outstrip income	18	44	12	39	25	38	7	47
Illiteracy	5	12	3	10	13	20	1	07
No nearby Bank	35	85	24	77	52	80	11	73

Source: Field Survey, 2015 Frequency greater than the number is due to multiple responses

The result shows the identified constraints as inadequate income, responsibility outstrip income, illiteracy and the absence of banking services in the communities. Among these factors, illiteracy was the least constraint to savings, contributing 12%, 10%, 20% and 7% to the poor savings of livestock, agro-processing, crop and fisheries economic interest groups respectively. Conversely, absence of banking facility within the community was a major constraint to savings of Fadama III economic interest groups, contributing 85%, 77%, 80% and 73% to poor savings of livestock, agro-processing, crop and fisheries economic interest groups respectively. These poor accesses to banking facilities show that majority of Fadama III farmers are financially excluded from financial services.

4.5 Analysis of Socio-economic Factors Determining the Adoption of Technology by Fadama III Beneficiaries in Benue State

4.5.1 Socio-economic Factors Affecting the Adoption of New Technology by Fadama III Economic Interest Group in Benue State

The socio-economic factor influencing the adoption of technology by Fadama III beneficiaries across the economic interest groups was analyzed. This included crop, agro-processing and livestock economic interest groups.

4.5.1 Socio-economic Factors Affecting the Adoption of New Technology by Fadama III Crop Economic Interest Group in Benue State

Information in Table 4.21 shows the result of the logit regression of socio-economic factors affecting the adoption of new technology by Fadama III Crop EIG in Benue State. All results on the estimation of the logit regression analysis are obtained using the Eviews Version 7 software.

Table 4.21: Logit Regression Result of Factors Affecting the Adoption of New Technology by Fadama III Crop EIG

Variable	Coefficient	Std. Error	z-Statistic	Prob.
SAR	-2.18	0.48	-4.51	0.00
OKG	1.00	0.30	3.33	0.01
PRI	0.88	0.35	2.48	0.02
ACM	0.11	0.09	1.15	0.33

ADS	-0.02	0.63	-3.18	0.75
TMF	-3.19	0.95	-3.34	0.00
FMS	0.86	0.30	2.84	0.01
CTF	-0.02	0.41	-4.87	0.63
CTA	0.04	0.57	0.07	0.93
CTSS	-0.88	0.36	-2.46	0.02
C	-3.77	1.55	-2.42	0.02

McFadden R-squared 0.46 Mean dependent var 0.74 LR Statistics 34.20 Prob (LR Statistics) 0.00

Source: Source: Author's computation using E-views 7

The result shows that output (OKG), access to market (ACM), Provision of input (PRI), farm size (FMS), and cost of agrochemicals (CTA) positively affect the adoption of technology by Fadama crop farmers in Benue State. These constitute driving forces that positively influence the behavioural change of Fadama III crop farmers in adopting new technology. On the other hand, savings (SAR), advisory services (ADS), timeliness in provision of counterpart funds (TMF), cost of fertilizer (CTF) and cost of seed/seedlings (CTSS) negatively affect the adoption of technology by Fadama III crop farmers, thus constituting inhibiting forces that negatively affect behavioural change in adopting new technology. Specifically, for every reduction in savings of Fadama III crop farmers, the probability of adopting new technology falls by 2.18 units. For every unit increase in output of Fadama III crop farmers, the probability of adopting new technology increases by 1unit. For every increase in access to market by Fadama III crop farmer, the probability of adopting new technology increases by 0.11units. For every reduction in advisory service to Fadama III crop farmers, the probability of adopting new technology decreases by 0.02 units. For every reduction of timelines in provision of funds to Fadama III crop farmers, the probability of adopting new technology reduces by 3.19 units. For each unit increase in farm size by Fadama III crop farmers, the probability of adopting new technology increases by 0.86 units. For every unit increase in the cost of fertilizer, the probability of adopting new technology reduces by 0.02 units. For every unit increase in the cost of agrochemicals, the probability of adopting new technology increases by 0.04 units and for every unit increase in the cost of seed, the probability of adopting new technology reduces by 0.88 units.

This means that output, provision of input and farm size positively and significantly influenced the adoption of technology by Fadama III crop farmers. The implication of this is that these variables significantly encourage farmers to adopt improved technology, therefore any improvement in them will increase the probability of adoption and this will lead to increase in output and income. Variables such as access to market and cost of agrochemical also have positive effect on the adoption of technology but their influence is not significant. The factors that significantly discourage the probability of adopting improved technology by Fadama III crop farmers are poor savings, untimely release of funds and cost of seeds/seedling. Others are advisory services and cost of fertilizer, but the effects of these were not significant. Therefore the timely release of funds to farmer, subsidizing the cost of seeds/seedling and encouraging farmers to save will go a long way to increase the output of Fadama III crop farmers in Benue State.

The McFadden R-squared value of 0.46 implies that the model presents a good fit, Louviere, Hensher and Swaith (2000), indicated that the McFadden R-squared value between 0.2-0.4 are considered to be indicative of extremely good fit equivalent to 0.7-0.9 for a linear function. The Log likelihood Ratio (LR) statistics value of 34.20 which is significant at 1% level shows a relatively strong joint effect of the explanatory variables on the dependent variable in the model.

4.5.1.2 Socio-economic Factors Affecting the Adoption of Technology by Fadama III Agro-processing Economic Interest Group in Benue State

Information in Table 4.22 shows the result of the logit regression of socio-economic factors that affect the adoption of technology by Fadama III Agro-processing EIG in Benue State.

Table 4.22: Logit Regression Result of Factors Affecting the Adoption of New Technology by Fadama III Agro-processing EIG

Variable	Coefficient	Std. Error	z-Statistic	Prob.
CTFW	0.47	0.19	2.48	0.02
SAR	-1.64	0.92	-1.78	0.64
OKG	0.90	0.30	3.00	0.01
ADS	0.23	0.17	1.34	0.23
CTP	-0.15	0.42	-0.55	0.80
ACM	0.17	0.91	0.19	0.17
TMF	-1.15	0.45	-2.56	0.02
C	0.82	2.98	0.28	0.82

McFadden R-squared 0.477 Mean dependent var 0.49
LR Statistics 15.55 Prob (LR Statistics) 0.03
Source: Author's computation using E-views

The result shows the driving forces to behavioral change as cost of fire wood (CTFW), output (OKG), advisory services (ADS), and access to market (ACM) positively influence the adoption of new technology by agro-processing farmers; while inhibiting forces like saving rate (SAR), cost of petrol (CTP) and timeliness of finance (TMF) negatively influence the adoption of technology by Fadama agro-processing farmers in Benue State. Specifically, for each unit increase in cost of firewood of Fadama III agro-processing farmers, the probability of adopting new technologies increase by 0.47 units. For every reduction in savings of Fadama III agro-processing farmers, the probability of adopting new technology falls by 1.64 units. For every unit increase in output of Fadama agro-processing farmers, the probability of adopting new technology increases by 0.90 units. For every unit increase in access to market by Fadama III agro-processing farmer, the probability of adopting new technology increases by 0.17 units. For each increase in advisory service to Fadama agro-processing farmers, the probability of adopting new technology increases by 0.23 units. For every reduction in timelines in provision of funds to Fadama agro-processing farmers, the probability of adopting new technology falls by 1.15 units and for every unit increase in cost of petrol to Fadama agro-processing farmers in Benue State, the probability of adopting new technology reduces by 0.15 units.

This means that, output and cost of firewood have the probability of significantly encouraging Fadama III agro-processing farmers to adopt improved technology; variables like advisory services and access to market have positive values but their effect are not significant. The implication of this finding is that with increase in output, farmers will be encouraged to adopt improved technology and this may lead to increase in income. The cost of firewood may be low and negligible, such that even if it increases, such increase may not affect the adoption of technology. On the other hand, the use of firewood should be discouraged as it has adverse effect on the environment and will affect environmental sustainability. Also, timely release of finance to Fadama III agro-processing farmers will significantly increase their adoption of improved technology, increase output and income.

The McFadden R-squared value of 0.48 suggests that the model presents a good fit. The L-R statistics value of 15.55 which is significant at 5% level shows a relatively strong joint effect of the explanatory variables on the dependent variable.

4.5.1.3 Socio-economic Factors Affecting the Adoption of Technology by Fadama III Livestock Economic Interest Group in Benue State

Data in Table 4.23 show the result of the logit regression of socio-economic factors that affect the adoption of technology by the Fadama III Livestock EIG in Benue State.

Table 4.23: Logit Regression Result of Factors Affecting the Adoption of New Technology by Fadama III Livestock EIG

Variable	Coefficient	Std. Error	z-Statistic	Prob.
HDS	0.20	0.08	2.42	0.02
OKG	0.60	0.27	2.22	0.03
ADS	0.01	0.08	0.18	0.86
CTFD	-0.56	0.20	-2.76	0.02
ACM	0.79	0.48	1.64	0.31
TMF	-0.27	0.08	-3.32	0.02
SAR	-0.68	0.29	-2.37	0.03
C	0.56	1.76	0.32	0.75

McFadden R-squared 0.37 Mean dependent var 0.73 LR Statistics 23.58 Prob (LR Statistics) 0.00

Source: Author's computation using E-views

The result shows that herd size (HDS), output (OKG), advisory services (ADS) and access to market (ACM) positively influence the adoption of technology by Fadama III livestock farmers in Benue State; while, cost of feeds (CTFD), timeliness of finance (TMF) and savings rate (SVR) negatively influence the adoption of technology by Fadama III livestock farmers in Benue State. Specifically, for every unit increase herd size by Fadama III livestock farmers in Benue State, the probability of adopting new technology increases by 0.21 units. For each increase in output, the probability of adopting new technology increases by 0.60 units. For every unit increase in cost of feeds, the probability of adopting new technology reduces by 0.56 units, for every fall in savings of Fadama Livestock farmers, the probability of adopting new technology falls by 0.69 units. For every unit increase in access to market by Fadama Livestock farmer, the probability of adopting new technology increases by 0.79 units. For each increase in advisory service to Fadama Livestock farmers, the probability of adopting new technology increases by 0.01 units. For every reduction of timelines in provision of funds to Fadama Livestock farmers, the probability of adopting new technology reduces by 0.27 units.

This means that herd size and output of Fadama III Livestock farmers significantly encourage them to adopt improved technology. This implies that the provision of improved breeds to farmers should be encouraged. Furthermore, access to market also increase the probability of adopting improved technology but the effect is not significant. On the other hand, cost of feeds, timeliness in provision of finance and poor savings of Fadama III livestock farmers significantly discourage them from adopting improved technology. Therefore, the timely provision of finance, low cost of feeds and the encouragement of farmers to save will serve as driving force to adopting improved technology and subsequent increase in output and income. The McFadden R-squared value of 0.37 shows that the model presents a good fit. The L-R statistics value of 23.58 which is significant at 1% level also shows a relatively strong joint effect of the explanatory variables on the dependent variable in the model.

4.5.2 Socio-economic Factors Affecting the Adoption of Technology by Individual Crop Farmers in Benue State

The socio-economic factor influencing the adoption of technology by Fadama III beneficiaries among individual crop farmers was analyzed. This included cassava, yam, rice and groundnut individual crop farmers.

4.5.2.1 Socio-economic Factors Affecting the Adoption of Technology by Fadama III Cassava Farmers in Benue State

Data in Table 4.24 show the result of the logit regression of socio-economic factors that affect the adoption of technology by the Fadama III cassava farmers in Benue State.

Table 4.24: Logit Regression Result of Factors Affecting the Adoption of New Technology by Fadama III Cassava Farmers

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FMS	0.22	0.36	0.59	0.55
FEMP	0.93	0.53	1.73	0.08
ADS	0.12	0.07	1.80	0.07
CTA	5.63	9.93	0.57	0.57
CTF	-5.80	4.84	-1.19	0.23
CTSL	-0.03	0.01	-2.39	0.02
AGE	-0.02	0.03	-0.64	0.52
SEX	-0.09	0.03	-3.25	0.00
EDU	0.03	0.05	0.59	0.55
OKG	5.51	0.00	0.20	0.84
C	0.35	2.39	0.14	0.88

McFadden R-squared 0.16 Mean dependent var 0.68 LR Statistics 18.54 Prob (LR Statistics) 0.05

Source: Author's computation using E-views

The result shows that farm size (FMS), output (OKG), education (EDU), formal employment (FEMP), advisory services (ADS), and cost of agrochemicals (CTA) positively influence the adoption of new technology by Fadama III cassava farmers in Benue State while age (AGE), sex (SEX), cost of fertilizer (CTF) and cost of seedling (CTSL) negatively affect the adoption of technology by Fadama III cassava farmers. Specifically, for each unit increase in farm size of Fadama cassava farmers, the probability of adopting new technology increases by 0.22 units, for every unit increase in output of Fadama III cassava farmers, the probability of adopting new technology increases by 5.51 units. For each increase in age of Fadama III cassava farmers, the probability of adopting new technology reduces by 0.02 units. For each increase in educational level and formal employment, the probability of adopting technology increases by 0.03 and 0.93 units respectively. For each increase in advisory service to Fadama cassava farmers, the probability of adopting new technology reduces by 0.12 units. For every unit increase in the cost of fertilizer, the probability of adopting new technology reduces by 5.80 units. For every unit increase in the cost of agrochemicals, the probability of adopting new technology increases by 5.63 units. For every unit increase in the cost of seedling, the probability of adopting new technology reduces by 0.03 units and for every additional male beneficiary of Fadama III cassava farmer, the probability of adopting new technology falls by 0.09 units.

Factors such as formal employment and advisory services positively and significantly influence the probability of adopting improved technology by Fadama III cassava farmers. This implies that the involvement of Fadama III cassava farmers into other formal employment aside farming is an added advantage because income from such formal employment may be used to purchase input and other farming tools. Therefore, the involvement of Fadama III cassava farmers in off-farm activities, if encouraged will enhance the adoption of improved technology. Furthermore, advisory services provided by agricultural development project (ADP) also significantly encourage their adoption of technology. On the other hand, the cost of fertilizer and additional male beneficiaries tend to have adverse effects on the adoption of technology by Fadama III cassava farmers.

The McFadden R-squared value of 0.16 suggests that the model presents a good fit. The L-R statistics value of 18.54 which is significant at 5% level shows a relatively strong joint effect of the explanatory variables on the dependent variable in the model.

4.5.2.2 Socio-economic Factors Affecting the Adoption of Technology by Fadama III Yam Farmers in Benue State

Information in Table 4.25 shows the result of the logit regression of factors that affect the adoption of technology by the Fadama III yam farmers in Benue State.

Table 4.25: Logit Regression Result of Factors Affecting the Adoption of New Technology by Fadama III Yam Farmers

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FMS	0.85	0.31	2.75	0.03
OKG	0.23	0.08	2.89	0.02
ADS	-0.02	0.08	-0.31	0.75
AGE	0.01	0.02	0.53	0.60
SEX	-1.77	0.49	-3.64	0.02
EDU	0.17	0.07	2.64	0.03
CTF	-0.65	0.23	-2.82	0.03
CTA	-0.57	0.22	-2.56	0.02
FEMP	0.77	0.46	1.68	0.09
ACM	0.05	0.17	0.33	0.73
CTSL	-0.44	0.10	-0.25	0.80
C	4.15	2.55	1.62	0.10

McFadden R-squared 0.41 Mean dependent var 0.55LR Statistics 18.76 Prob (LR Statistics) 0.01

Source: Author's computation using E-views

The result shows that farm size (FMS), output (OKG), age (AGE), education (EDU), formal employment (FEMP) and access to market (ACM) positively influence the adoption of new technology by Fadama III yam farmers in Benue State while advisory services (ADS), sex (SEX), cost of fertilizer (CTF) and cost of seedling (CTSL) negatively affect the adoption of technology by Fadama III yam farmers. Specifically, for each unit increase in farm size of Fadama yam farmers, the probability of adopting new technology increases by 0.85 units, for every unit increase in output of Fadama III yam farmers, the probability of adopting new technology increases by 0.23 units. For each increase in age of Fadama III yam farmers, the probability of adopting new technology increases by 0.01units. For each increase in educational level and formal employment, the probability of adopting technology increases by 0.17 and 0.77 units respectively. For every unit increase in access to market by Fadama III yam farmer, the probability of adopting new technology increases by 0.05units. For every fall in advisory service to Fadama yam farmers, the probability of adopting new technology reduces by 0.02 units. For every unit increase in the cost of fertilizer, the probability of adopting new technology reduces by 0.65 units. For every unit increase in the cost of agrochemicals, the probability of adopting new technology reduces by 0.57 units. For every unit increase in the cost of seedling, the probability of adopting new technology reduces by 0.44 units and for every additional male yam farmer, the probability of adopting new technology falls by 1.77 units.

From the statistics given, factors such as farm size, output, educational level and formal employment have significantly increased the probability of adopting improved technology. This implies that any improvement in these variables will positively and significantly increase adoption rate for Fadama III yam farmers. On the other hand, cost of fertilizer and agro-chemicals and the involvement of additional male are inhibiting factors militating against adoption of technology by Fadama yam farmers. Therefore any reduction in the cost of these inputs and involvement of female beneficiaries will improve their adoption rate.

The McFadden R-squared value of 0.41 implies that the model has a good fit. The L-R statistics value of 18.76 is significant at 5% level and it shows a relatively strong joint effect of the explanatory variables on the dependent variable.

4.5.2.3 Socio-economic Factors Affecting the Adoption of Technology by Fadama III Rice Farmers in Benue State

Data in Table 4.26 show the result of the logit regression of socio-economic factors that affect the adoption of technology by Fadama III rice farmers in Benue State.

Table 4.26: Logit Regression Result of Factors Affecting the Adoption of New Technology by Fadama III Rice Farmers

Variable	Coefficient	Std. Error	z-Statistic	Prob.

FMS	1.20	0.37	3.23	0.02
OKG	-0.21	0.18	-1.14	0.25
ADS	-0.11	0.05	-2.19	0.02
AGE	-0.04	0.03	-1.57	0.11
SEX	-0.14	0.61	-0.23	0.82
EDU	1.08	0.34	3.15	0.02
CTF	0.03	0.03	1.04	0.29
CTA	-0.48	0.10	-4.55	0.00
FEMP	0.22	0.47	0.48	0.63
ACM	-0.52	0.41	-1.26	0.97
CTS	-0.73	0.21	-3.47	0.02
C	2.93	1.84	1.59	0.11

McFadden R-squared 0.44 Mean dependent var 0.65 LR Statistics 9.89 Prob (LR Statistics) 0.63

Source: Author's computation using E-views

The result shows that farm size (FMS), level of education (EDU), cost of fertilizer (CTF) and formal employment (FEMP) positively affect the adoption of technology by rice farmers, while sex (SEX), outputs (OKG), advisory services (ADS), age (AGE), cost of agrochemical (CTA), access to market (ACM) and cost of seed (CTS) negatively affect the adoption of technology by Fadama III rice farmers. Specifically, for every increase in farm size of Fadama rice farmers, the probability of adopting new technology increases by 1.20 units. For every fall in output of Fadama rice farmers, the probability of adopting new technology decreases by 0.21 units. For every reduction in the provision of advisory information to Fadama rice farmers, the probability of adopting new technology decreases by 0.11 units. For each increase in age of Fadama rice farmer, the probability of adopting new technology reduces by 0.04 units. For each additional male Fadama III rice farmers, the probability of adopting new technology reduces by 0.14 units. For every increase in level of education to Fadama rice farmers, the probability of adopting new technology increases by 1.08 units. For each unit increase in cost of fertilizer by Fadama rice farmers, the probability of adopting new technology increase by 0.03 units. For every increase in the cost of agrochemical to Fadama III rice farmers, the probability of adopting new technology reduces by 0.48 units. For each unit increase in formal employment, the probability of adopting new technology increases by 0.23 units. For each reduction in access to market, the probability of adopting new technology falls by 0.52 units. For every increase in cost of seed to Fadama III rice farmers, the probability of adopting new technology decreases by 0.73 units.

From the results on Table 4.26, farm size and output of Fadama III rice farmer have the probability of significantly increasing the adoption of improved technology. This implies that improvement in these factors will significantly improve their adoption rates. On the other hand, advisory services, cost of seed and agro-chemicals significantly militate against the adoption of improved technology.

The McFadden R-squared value of 0.44 suggests that the model presents a good fit. The L-R statistics value of 9.89 is not significant and shows a relatively weak joint effect of the explanatory variables on the dependent variable in the model.

4.5.2.4 Socio-economic Factors Affecting the Adoption of Technology by Fadama III Groundnut Farmers in Benue State

Data in Table.27 show the result of the logit regression of socio-economic factors that affect the adoption of technology by Fadama III groundnut farmers in Benue State.

Table 4.27: Logit Regression Result of Factors Affecting the Adoption of New Technology by Fadama III Groundnut Farmers

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FMS	4.69	3.07	1.52	0.13
OKG	2.36	0.90	2.63	0.01
ADS	0.41	1.08	0.38	0.70

AGE	-1.51	1.13	-1.34	0.18
SEX	-1.33	1.06	-1.25	0.21
LEDU	0.09	1.15	0.08	0.94
CTF	-0.32	1.04	-0.31	0.76
CTA	-0.43	0.15	-2.79	0.01
FEMP	3.15	1.24	2.54	0.01
ACM	0.77	0.55	1.41	0.16
CTS	-6.26	3.47	-0.02	0.98
C	5.25	3.57	1.47	0.14

McFadden R-squared 0.41 Mean dependent var 0.75 LR Statistics 29.17 Prob (LR Statistics) 0.00

Source: Author's computation using E-views

The result shows that farm size (FMS), output (OKG), advisory services (ADS), education (EDU), formal employment (FEMP) and access to market (ACM) positively affect the adoption of technology by Fadama III groundnut farmers, while age (AGE), sex (SEX), cost of fertilizer (CTF), cost of agrochemical (CTA) and cost of seed (CTS) negatively affect the adoption of technology by Fadama III groundnut farmers. Specifically, for every unit increase in farm size of Fadama groundnut farmers, the probability of adopting new technology increases by 4.69 units. For each unit increase in output of Fadama groundnut farmers, the probability of adopting new technology increases by 2.36 units. For every unit increase in the provision of advisory information to Fadama groundnut farmers, the probability of adopting new technology increases by 0.41 units. For each increase in age of Fadama groundnut farmers, the probability of adopting new technology reduces by 1.51 units. For every additional male Fadama III groundnut farmers, the probability of adopting new technology reduces by 1.33 units. For each unit increase in level of education to Fadama groundnut farmers, the probability of adopting new technology increases by 0.09 units. For every increase in cost of fertilizer by Fadama groundnut farmers, the probability of adopting new technology reduces by 0.32 units. For each unit increase in the cost of agrochemical by Fadama groundnut farmers, the probability of adopting new technology reduces by 0.43 units. For every unit increase in formal employment, the probability of adopting new technology increases by 3.14 units. For every increase in access to market, the probability of adopting new technology increases by 0.77 units and for every increase in cost of seed to Fadama groundnut farmers, the probability of adopting new technology decreases by 6.26 units.

The result on Table 4.27 shows that output and formal employment have the probability of significantly influencing the adoption of improved technology by Fadama III groundnut farmers. This implies that the involvement of Fadama III groundnut farmers into other employment activities aside farming is an added advantage because income from such employment may be used to purchase input and other farming tools. Therefore, the involvement of Fadama III cassava farmers in off-farm activities, if encouraged will enhance the adoption of improved technology. On the other hand, cost of agro-chemicals significantly militates against adoption of improved technology. Other factors like cost of fertilizer and seed cost also reduce the adoption rate of Fadama III groundnut farmers but their effects are not significant.

The McFadden R-squared value of 0.41 suggests that the model presents a good fit. The L-R statistics value of 29.17 which is significant at 1% level shows a relatively strong joint effect of the explanatory variables on the dependent variable in the model.

4.6 Analysis of the Efficiency of production by Fadama III Beneficiaries in Benue State

4.6.1 Estimates of the Stochastic Frontier Production Function of Fadama III Economic Interest Groups

The estimates of the Stochastic Frontier production function of Fadama III economic interest groups were analyzed for crop, agro-processing and livestock economic interest groups.

4.6.1.1 The Maximum Likelihood Estimates of the Stochastic Frontier production function for Fadama III Crop EIG

The maximum likelihood estimates of the Stochastic Frontier production function for Fadama III crop farmers are presented in Table 4.28. The results are obtained using Frontier Version 4.1 software.

Table 4.28: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Crop Farmers in Benue State

Variable	Parameter	Estimate	Standard Error	t-ratio
Stochastic frontier				
Constant	X_0	8.11	0.11	70.71
Ln(Farm size)	X_1	0.27	0.08	3.52*
Ln(Seed)	X_2	-0.23	0.71	-0.33
Ln(Fertilizer)	X_3	0.54	0.06	9.81*
Ln(Agrochemicals)	X_4	-0.04	0.05	-0.67
Ln(Labour)	X_5	0.63	0.11	5.82*
Inefficiency Model				
Constant	Z_0	2.51	0.13	18.42
Advisory services	Z_1	-0.51	0.14	-3.73*
Saving rate	Z_2	0.35	0.16	2.31*
Timeliness in provision of finance	Z_3	0.01	0.002	6.05*
Provision of inputs	Z_4	-0.15	0.16	-0.93
Adoption of	Z_5	-0.17	0.13	-1.3

technology				
Variance				
Parameters				
Sigma squared	δ^2	0.15	0.02	6.07*
Gamma	Γ	0.63	0.11	5.51
Ln likelihood		-14.68		

Source: Author's computation using Frontier 4.1 *t-ratio is significant at 5% level of significance.

Table 4.28 shows that the elasticities of frontier output of Fadama III crop farmers was estimated to be an increasing function of farm size (0.27), fertilizer (0.54) and labour (0.63) and a decreasing function of seed/seedling (-0.23) and agrochemical (-0.04). More specifically the result showed that farm size significantly (at 5% level) increased crop output, also fertilizer and labour significantly (at 1% levels) increased crop output; while seed and agro-chemicals reduced the output of crop farmers but their effects are not significant. The return to scale parameter otherwise known as elasticity of scale, defined by Coelli, Rao, O'Donnel and Battese (2005) as the total elasticity of production was calculated. Although some authors, like Asogwa (2010) defined return to scale as the sum of the elasticities of all significant input variable, this work has employed the definition by Coelli *et al*. (2005) in the analysis because they were the initial developers of the Stochastic Frontier Production Model .The returns to scale for Fadama III crop farmers was found to be 1.71 implying increasing return to scale for production among Fadama III crop farmers in Benue State. This suggests that a proportionate increase in all the inputs will lead to more than proportionate increase in output of Fadama III crop farmers in Benue State. This increasing return-to-scale implies increasing productivity per unit of input and suggests that they are not utilizing their resources efficiently. This means that they can still increase their level of output at the current level of resources and this will result to higher output.

The explanatory variables in the inefficiency model are used to explain the inefficiency in production among Fadama crop farmers. The estimated coefficients of timeliness in provision of finance (0.01), and saving rate (0.35) increased the inefficiency of Fadama crop farmers, the effects of timeliness in provision of input and saving significantly reduced efficiency in production. The estimated coefficients of advisory services (-0.51), provision of inputs (-0.15) and adoption of technology (-0.17) reduced inefficiencies in Fadama crop production but only the effect of advisory services is significant. The results showed a gamma of 0.63 implying that 63% of the variations in productivity of Fadama III crop farmers were determined by technical inefficiency variables. This indicated that reducing technical inefficiency among respondents will result in substantial productivity increases. The Sigma squared (δ^2) of 0.15 was significant at 1% indicating a good fit.

4.6.1.2 The Maximum Likelihood Estimates of the Stochastic Frontier production function for Fadama III Agro-processing EIG

The maximum likelihood estimates of the Stochastic Frontier production function for Fadama III agro-processing farmers are presented in Table 4.29.

Table 4.29: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Agro-processing Farmers in Benue State

Variable	Parameter	Estimate	Standard Error	t-ratio
Stochastic frontier				
Constant	π_0	6.00	0.76	7.91
Ln(Quantity of product processed)	π_1	0.50	0.07	6.65*
Ln(Quantity of fuel)	π_2	-0.12	0.13	-0.94
Ln(Quantity of firewood)	π_3	0.57	0.07	8.29*

Ln(Labour)	π_4	-0.03	0.02	-1.20
Inefficiency Model				
Constant	$\int_0$	0.19	0.49	0.40
Advisory services	$\int_1$	0.02	0.02	0.74
Saving rate	$\int_2$	0.15	0.13	1.13
Timeliness in finance	$\int_3$	0.19	0.07	2.43*
Adoption of technology	$\int_4$	-0.18	0.09	-2.03*
Variance Parameters				
Sigma squared	δ^2	0.11	0.02	4.32*
Gamma	Γ	0.52	0.02	21.06
Ln likelihood		-10.42		

Source: Author's computation using Frontier 4.1 *t-ratio is significant at 5% level of significance.

The maximum likelihood estimates of Stochastic Frontier production function, as presented in Table 4.29, show that the elasticities of frontier output of Fadama III agro-processing farmers are estimated to be an increasing function of quantity of product processed (0.50) and firewood (0.57) and a decreasing function of fuel (-0.12), and labour (-0.03). More specifically the result shows that the positive effect of quantity of product processed and firewood significantly increased output of agro-processing farmers, while the negative effect of labour and fuel reduced output of agro-processing farmer but their effects are not significant. The return to scale parameter for Fadama III agro-processing famers was found to 1.22 implying increasing return to scale for production among the agro-processing farmers in Benue State. This suggests that a proportionate increase in all the inputs will lead to more than proportionate increase in their output. This increasing return-to-scale implies increasing productivity per unit of input and suggests that Fadama III agro-processing farmers in Benue State are not using their resources efficiently and can still increase their level of output at the current level of resources resulting into higher output.

The explanatory variables in the inefficiency model show that the estimated coefficients of advisory services (0.02), timeliness in provision of finance (0.09) and saving rate (0.15) increased the inefficiency of Fadama agro-processing farmers, the positive effects of advisory services is significant. The estimated coefficients of adoption of technology (-0.18) reduced inefficiencies in Fadama III agro-processing production but the effects are also not significant. The results showed a gamma of 0.52 implying that 52% of the variations in productivity of Fadama agro-processing farmers were determined by technical inefficiency variables. This indicated that reducing technical inefficiency among respondents will result in substantial productivity increases. The Sigma squared (δ^2) of 0.11 was significant at 1% indicating a good fit. Also to check for possible effect of multi-collinearity between firewood (X1) and fuel(X2), the variance inflator factor (VIF) value of 4.30 showed the absence of multi-collinearity (see Appendix V E).

4.6.1.3 The Maximum Likelihood Estimates of the Stochastic Frontier production function for Fadama III livestock EIG.

The maximum likelihood estimates of the Stochastic Frontier production function for Fadama III livestock farmers are presented in Table 4.30.

Table 4.30: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Livestock Farmers in Benue State

Variable	Parameter	Estimate	Standard Error	t-ratio
Stochastic frontier				
Constant	λ_0	4.59	1.0	4.59*
Ln(Herd size)	λ_1	0.28	0.13	2.02*
Ln(Feed)	λ_2	-0.24	0.97	-2.46*
Ln(Group labour)	λ_3	0.04	0.05	0.67
Ln(Hired labour)	λ_4	-0.60	0.19	-3.13*
Inefficiency Model				

Constant	Ω_0	-0.39	0.32	-0.23
Advisory services	Ω_1	0.27	0.08	3.59*
Saving rate	Ω_2	0.06	0.02	3.54*
Timeliness in provision of finance	Ω_3	0.33	0.23	1.41
Adoption of technology	Ω_4	-0.11	0.24	-0.46
Variance Parameters				
Sigma squared	δ^2	0.76	0.24	3.21*
Gamma	Γ	0.86	0.92	0.93
Ln likelihood		-37.56		

Source: Author's computation using Frontier 4.1 *t-ratio is significant at 5% level of significance.

The individual coefficients of the explanatory variables in the Cobb-Douglas production function represent the elasticities of the output of Fadama III livestock farmers with respect to the inputs. The production elasticities of frontier output with respect to herd size, feeds, group labour and hired labour were estimated to be 0.28, -0.24, 0.04 and -0.60 respectively. Given the specifications of the Cobb-Douglas frontier models, the result shows that the elasticity of mean value of livestock output was estimated to be an increasing function of herd size and group labour and a decreasing function of feeds and hired labour. More specifically, the result showed that herd size significantly (at 1% level) increased livestock output, while group labour has positive but insignificant increase on livestock output. Hired labour has a negative but insignificant effect on livestock output, but feeds have a negative and significant (at 1% level) effect on livestock output. The return to scale parameter was found to be 1.16 implying increasing return to scale for production among Fadama III livestock farmers. This suggests that a proportionate increase in all the inputs will lead to more than proportionate increase in output. This increasing return-to-scale implies increasing productivity per unit of input and suggests that

Fadama III livestock farmers can still increase their level of output at the current level of resources and this will result to higher output.

The explanatory variables in the inefficiency model shows that the estimated coefficients of advisory services (0.27), timeliness in provision of finance (0.33), and savings (0.06) increased the inefficiency of Fadama III livestock farmers. The positive effect of advisory services and savings significantly increased the inefficiency of livestock production, but the effect of timeliness in provision of finance is not significant. The estimated coefficients of adoption of technology (-0.11) reduced inefficiencies in Fadama livestock production but the effect is not significant. The results showed a gamma of 0.86 implying that 86% of the variations in productivity of Fadama III livestock farmers were determined by technical inefficiency variables. This indicated that reducing technical inefficiency among respondents will result in substantial productivity increases. The Sigma squared (δ^2) of 0.76 was significant at 1% indicating a good fit.

4.6.1.4 Distribution of Technical Efficiency Estimates of Fadama III Economic Interest Groups

The distribution of technical efficiency estimates of Fadama III economic interest groups was analyzes and the result is presented in Table 4.31.

Table 4.31: Distribution of Technical Efficiency Estimates of Fadama III Economic Interest Groups

Technical Efficiency	**Crop EIG**		**Livestock EIG**		**Agro processing EIG**	
Range	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0.0-0.20	16	24.62	0	0	0	0
0.21-0.40	22	33.85	0	3.33	0	0
0.41-0.60	12	18.46	0	30	2	5.71
0.61-0.80	6	9.23	13	30	15	42.86

0.81-1.00	9	13.85	28	36.67	18	51.43
Total	**65**	**100**	**41**	**100**	**35**	**100**
Min. Efficiency	**0.11**		**0.68**		**0.60**	
Max. Efficiency	**1.00**		**1.00**		**1.00**	
Mean Efficiency	**0.41**		**0.87**		**0.81**	

Source: Field Survey, 2015

Information in Table 4.31 shows the technical efficiency estimates for Fadama III EIGs grouped by crop, livestock and agro-processing. The efficiency estimates varied substantially ranging between 0.00 to1.0, with a mean efficiency of 0.41, 0.87 and 0.81 for crop, livestock and agro-processing EIGs respectively. This result suggests that the Fadama III farmers were not utilizing their production resources efficiently, indicating that they were not obtaining maximum output from their given quantum of inputs. In other words technical efficiency among the EIGs could be increased by 0.59, 0.13 and 0.19 for crop, livestock and agro-processing EIGs respectively to enable the farmers obtain maximum output and hence increase their farm incomes thereby reducing poverty. The result shows that crop EIG had the least technical efficiency with a minimum efficiency of 0.11 while livestock EIG had the highest technical efficiency with a minimum efficiency of 0.68 The result also shows that 94.29% of respondent in the agro-processing EIG operated at the technical efficiency range of 0.61 to1.00, 100% of respondent in the livestock EIG operated at the technical efficiency range of 0.61 to 1.00 while only 23.03% of respondent in the crop EIG operated at the technical efficiency range of 0.61 to 1.00.

4.6.1.5 Difference in Technical Efficiency of Fadama III Beneficiaries across the Economic Interest Groups

To test for the difference in the technical efficiency of Fadama III beneficiaries across the economic interest groups, the analysis of variance test was conducted and the result is presented in Table 4.32.

Table 4.32: ANOVA on the Difference in Technical Efficiency of Fadama III Beneficiaries across the Economic Interest Groups

Method	Df	Value	Probability
Anova F-test	(2, 138)	75.95923	0.0000
Welch F-test*	(2, 91.0897)	69.12125	0.0000

Category Statistics

Variable	Count	Mean	Std.Dev.	Std. Err. of Mean
AGROEFF	35	0.809714	0.116908	0.019761
LIVEFF	41	0.868537	0.124209	0.019398
CROPEFF	65	0.409077	0.277465	0.034415
All	141	0.642128	0.300285	0.025289

Source: Author's computation using E-views

The result shows the mean efficiency of 0.81, 0.87and 0.41 for agro-processing, livestock and crop EIG respectively. The F-test value of 76.00 with the probability value of 0.00 is statistically significant at 1% level. The Welch F-test is used when the assumption of homogeneity of variance is violated; it shows an F-test value of 69.12 with a probability value of 0.00, meaning that the difference in technical efficiency is significant at 1% level. This implies that there is a significant difference in the technical efficiency of Fadama III economic interest group in Benue State.

4.6.2 Estimates of the Stochastic Frontier Production Function of Fadama III Individual Crop Farmers

The estimates of the Stochastic Frontier production function of Fadama III individual crop farmers grouped as yam, rice, groundnut and cassava farmers was analyzed and the results presented.

4.6.2.1 Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III yam Farmers in Benue State

The maximum likelihood estimates of the Stochastic Frontier production function of Fadama III individual crop farmers were analyzed and the result for Fadama III yam farmers is presented in Table 4.33.

Table 4.33: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III yam Farmers in Benue State

Variable	Parameter	Estimate	Standard Error	t-ratio
Stochastic frontier				
Constant	δ_0	1.14	0.35	3.23*
Ln(Farm size)	δ_1	0.37	0.33	1.12
Ln(Seed/Seedling)	δ_2	0.02	0.004	3.8*
Ln(Fertilizer)	δ_3	-0.16	0.06	-2.67*
Ln(Agrochemicals)	δ_4	-1.46	0.60	-1.99*
Ln(Labour)	δ_5	0.28	0.26	1.07

Inefficiency Model				
Constant	Ψ_0	1.58	0.06	27.43*
Advisory services	Ψ_1	-0.15	0.20	-0.76
Adoption of technology	Ψ_2	0.02	0.01	4.52*
Age	Ψ_3	0.01	0.02	0.29
Sex	Ψ_4	-0.21	0.09	-2.23*
Formal employment	Ψ_5	-0.56	0.15	-3.73*
Variance Parameters				
Sigma squared	δ^2	0.01	0.0007	10.58*
Gamma	Γ	0.84	0.03	32.43
Ln likelihood		-143.48		

Source: Author's computation using Frontier 4.1 *t-ratio is significant at 5% level of significance.

The maximum likelihood estimates of Stochastic Frontier production function as presented in Table 4.33 Shows that the elasticities of frontier output of Fadama III yam farmers was estimated to be an increasing function of farm size (0.37), seedling (0.02) and labour (0.28), and a decreasing function of fertilizer (-0.16) and agrochemical (-1.46). The result also showed that the positive effects of farm size and labour are not significant but that of seedling is significant at 1% levels; the negative effects of fertilizer and agrochemical are significant at 5% levels respectively. The return to scale parameter for Fadama III yam farmers was found to 2.29 implying increasing return to scale. This suggests that a proportionate increase in all the inputs will lead to more than proportionate increase in their output. This increasing return-to-scale implies increasing productivity per unit of input and suggests that Fadama III yam farmers can still increase their level of output at the current level of resources as this will result to higher output.

The explanatory variables in the inefficiency model show that the estimated coefficients of advisory services (-0.15), sex (-0.21) and formal employment (-0.56) reduced inefficiencies in Fadama yam production while adoption of technology (0.002) and age (0.01) increased the inefficiency of Fadama yam farmers. The results showed a gamma of 0.84 implying that 84% of the variations in productivity of Fadama III yam farmers were determined by technical inefficiency variables. This indicated that reducing technical inefficiency among respondents will result in substantial productivity increases. The Sigma squared (δ^2) of 0.01 was significant at 1% indicating a good fit.

4.6.2.2 Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Rice Farmers in Benue State

The maximum likelihood estimates of the Stochastic Frontier production function for Fadama III rice farmers are presented in Table 4.34.

Table 4.34: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Rice Farmers in Benue State

Variable	Parameter	Estimate	Standard Error	t-ratio
Stochastic frontier				
Constant	$ȣ_0$	9.60	1.88	5.09*
Ln(Farm size)	$ȣ_1$	1.24	0.52	2.38*
Ln(Seed)	$ȣ_2$	-0.09	0.59	-0.17
Ln(Fertilizer)	$ȣ_3$	0.01	0.06	0.09
Ln(Agrochemicals)	$ȣ_4$	-0.02	0.27	-2.35*
Ln(Labour)	$ȣ_5$	-0.05	0.52	-0.18
Inefficiency Model				
Constant	Φ_0	-0.04	0.52	-0.08
Advisory services	Φ_1	0.05	0.18	0.27
Adoption of technology	Φ_2	0.38	3.03	0.12

Age	Φ_3	-0.08	0.23	-0.30
Sex	Φ_4	0.12	0.58	0.20
Formal employment	Φ_5	-0.01	0.68	-0.02
Variance Parameters				
Sigma squared	δ^2	0.51	0.18	2.83*
Gamma	Γ	0.57	0.17	3.43
Ln likelihood		-74.69		

Source: Author's computation using Frontier 4.1 *t-ratio is significant at 5% level of significance.

The maximum likelihood estimates of Stochastic Frontier production function as presented in Table 4.34 shows that the elasticities of frontier output of rice farmers was estimated to be an increasing function of farm size (1.24) and fertilizer (0.01) and a decreasing function of seed (-0.09), agrochemical (-0.02) and labour (-0.05). The result also showed that the positive effect of farm size is significant at 1% level; the positive effect of fertilizer is not significant but the negative effect of agrochemical is significant at 1% levels while the negative effects of labour and seed are not significant. The return to scale parameter for Fadama rice famers was found to be 1.41 implying increasing return to scale. This suggests that a proportionate increase in all the inputs will lead to more than proportionate increase in output of Fadama III rice farmers in Benue State. This increasing return-to-scale implies increasing productivity per unit of input and suggests that Fadama III rice farmers in Benue State can still increase their level of output at the current level of resources and this will result to higher output.

The explanatory variables in the inefficiency model shows that the estimated coefficients of advisory services (0.05), adoption of technology (0.38) and sex (0.12) increased inefficiencies of Fadama III rice production while the coefficients of provision of age (-0.08) and formal employment (-0.01) reduced inefficiencies of Fadama rice farmers but their effects are not significant. The results showed a gamma of 0.57 implying that 57% of the variations in productivity of Fadama III rice farmers were determined by technical inefficiency variables. This indicated that reducing technical inefficiency among respondents will result in substantial productivity increases. The Sigma squared (δ^2) of 0.51 was significant at 1% indicating a good fit.

4.6.2.3 Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Groundnut Farmers in Benue State

The maximum likelihood estimates of the Stochastic Frontier production function for Fadama III Groundnut farmers are presented in Table 4.35.

Table 4.35: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Groundnut Farmers in Benue State

Variable Stochastic frontier	**Parameter**	**Estimate**	**Standard Error**	**t-ratio**
Constant	œ_0	6.52	0.66	9.89*
Ln(Farm size)	œ_1	1.07	0.24	4.43*
Ln(Seed)	œ_2	0.19	0.09	2.09*
Ln(Fertilizer)	œ_3	0.03	0.01	3.77*
Ln(Agrochemicals)	œ_4	0.24	0.18	1.31
Ln(Family labour)	œ_5	-0.13	0.08	-1.63
Ln (Hired labour)	œ_6	-0.51	0.20	-2.52*
Inefficiency Model				
Constant	ʒ_0	-0.32	0.72	-0.44
Advisory services	ʒ_1	0.39	0.18	2.17*
Adoption of technology	ʒ_2	0.03	0.02	2.15*
Age	ʒ_3	-0.08	0.16	-0.48
Sex	ʒ_4	0.11	0.35	0.30
Formal	ʒ_5	-0.05	0.09	-0.56

employment				
Variance				
Parameters				
Sigma squared	δ^2	0.36	0.03	10.43*
Gamma	Γ	0.89	0.16	5.60
Ln likelihood		-20.78		

Source: Author's computation using Frontier 4.1 *t-ratio is significant at 5% level of significance.

The maximum likelihood estimates of Stochastic Frontier production function as presented in Table 4.35 shows that the elasticities of frontier output of groundnut farmers was estimated to be an increasing function of farm size (1.07), seed (0.19), fertilizer (0.03) and agrochemical (0.24) and a decreasing function of family labour (-0.13) and hired labour (-0.51). The result also showed that the positive effect of farm size and fertilizer are significant at 1% level; the positive effect of seed and the negative effect of hired labour are both significant at 5% while the positive effect of agrochemical and the negative effect of family labour are not significant. The return to scale parameter for Fadama III groundnut famers was found to be 2.17 implying increasing return to scale. This increasing return-to-scale means that they can still increase their level of output at the current level of resources and this will result to higher output.

The explanatory variables in the inefficiency model shows that the estimated coefficients of advisory services (0.39), adoption of technology (0.03) and sex (0.11) increased the inefficiency of Fadama III groundnut farmers. Although the positive effect of advisory services is significant, that of adoption of technology and sex is not significant. The estimated coefficients of age (-0.08), and formal employment (-0.05) reduced inefficiencies in Fadama III groundnut production but their effects are not significant. The results showed a gamma of 0.89 implying that 89% of the variations in productivity of Fadama III groundnut farmers were determined by technical inefficiency variables. This indicated that reducing technical inefficiency among respondents will result in substantial productivity increases. The Sigma squared (δ^2) of 0.36 was significant at 1% indicating a good fit.

4.6.2.4 Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Cassava Farmers in Benue State

The maximum likelihood estimates of the Stochastic Frontier production function for Fadama III cassava farmers are presented in Table 4.36.

Table 4.36: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Production Model for Fadama III Cassava Farmers in Benue State

Variable Stochastic frontier	Parameter	Estimate	Standard Error	t-ratio
Constant	β_0	7.95	0.71	11.23
Ln(Farm size)	β_1	0.03	0.10	0.24
Ln(Seedling)	β_2	1.67	0.26	6.43*
Ln(Fertilizer)	β_3	0.003	0.01	0.34
Ln(Agrochemicals)	β_4	0.03	0.01	2.77*
Ln(Labour)	β_5	-0.03	0.17	-0.15
Inefficiency Model				
Constant	δ_0	1.18	0.44	2.68*
Advisory services	δ_1	0.06	0.18	0.34
Adoption of technology	δ_2	-0.07	0.03	-2.41*
Age	δ_3	0.12	0.18	0.66
Sex	δ_4	0.19	0.15	1.31
Formal employment	δ_5	-0.08	0.04	-1.98*

Variance Parameters				
Sigma squared	δ^2	0.19	0.06	2.94*
Gamma	Γ	0.81	0.17	4.86
Ln likelihood		-30.17		

Source: Author's computation using Frontier 4.1 *t-ratio is significant at 5% level of significance.

The maximum likelihood estimates of Stochastic Frontier production function as presented in Table 4.36 shows that the elasticities of frontier output of Fadama III cassava farmers was estimated to be an increasing function of farm size (0.03), seedling (1.67), fertilizer (0.003), and agrochemical (0.03) and a decreasing function of labour (-0.03). The result also showed that the positive effects of farm size and fertilizer are not significant; the positive effect of seedling is significant at 1% level, the positive effect of agrochemical is significant at 10% levels and the negative effect of labour is not significant. The return to scale parameter for Fadama III cassava famers was found to 1.76 implying increasing return to scale. This increasing return-to-scale implies that Fadama III cassava farmers can still increase their level of output at the current level of resources and this will result to higher output.

The explanatory variables in the inefficiency model shows that the estimated coefficients of advisory services (0.06), age (0.12) and sex (0.19) increased inefficiencies of Fadama III cassava farmers, while the coefficients of adoption of technology (-0.07) and formal employment (-0.08) decreased the inefficiency of Fadama III cassava farmers. The positive effect of advisory services, age and sex are not significant, the negative effect of adoption of technology is also not significant but the negative effect of formal employment is significant at 5% level. The results showed a gamma of 0.81 implying that 81% of the variations in productivity of Fadama III cassava famers were determined by technical inefficiency variables.

This indicated that reducing technical inefficiency among respondents will result in substantial productivity increases. The Sigma squared (δ^2) of 0.19 was significant at 1% indicating a good fit.

4.6.2.5 Distribution of Technical Efficiency Estimates of Fadama III Individual Crop Farmers

The distribution of technical estimates of Fadama III individual crop farmers in Benue State was analyzed and the result was presented in Table 4.37.

Table 4.37: Distribution of Technical Efficiency Estimates of Fadama III Individual Crop Farmers

Technical Efficiency	**Yam**		**Groundnut**		**Rice**		**Cassava**	
Range	F	%	F	%	F	%	F	%
0.0-0.20	0	0	1	1.59	8	7.62	0	0
0.21-0.40	26	21.67	8	12.70	40	38.10	8	8.70
0.41-0.60	7	5.83	26	41.26	26	24.75	29	31.52
0.61-0.80	48	40	16	25.40	15	14.29	25	27.17
0.81-1.00	39	32.5	12	19.05	16	15.24	30	32.61
Total	**120**	**100**	**63**	**100**	**105**	**100**	**92**	**100**
Min. Efficiency	**0.32**		**0.16**		**0.04**		**0.23**	
Max. Efficiency	**1.00**		**1.00**		**1.00**		**0.93**	
Mean Efficiency	**0.67**		**0.59**		**0.47**		**0.65**	

Source: Field survey, 2015

Information in Table 4.37 shows the technical efficiency estimates for Fadama III individual farmers grouped by yam, groundnut, rice and cassava. The efficiency estimates varied substantially ranging between 0.00 to 1.0, with a mean efficiency of 0.67, 0.59, 0.47 and 0.65 for yam, groundnut, rice and cassava farmers respectively. This result suggested that the Fadama III farmers were not utilizing their production resources efficiently, indicating that they were not obtaining maximum output from their given quantum of inputs. In other words, technical efficiency among the individual crop farmers could be increased by 0.33, 0.41, 0.53 and 0.35 for yam, groundnut, rice and cassava farmers respectively to enable the farmers obtain maximum output and hence increase their farm incomes thereby reducing poverty. The result shows that rice farmers had the least technical efficiency with a minimum efficiency of 0.04 and yam farmers had the highest technical efficiency with a minimum efficiency of 0.32. The result also shows that 72.50% of yam farmers operated at the technical efficiency range of 0.61 to 1.00, 59.78% of cassava farmers operated at the technical efficiency range of 0.61 to 1.00, 44.45% of groundnut farmers operated at the technical efficiency range of 0.61 to 1.00 while only 29.53% of rice farmers operated at the technical efficiency range of 0.61 to 1.00.

4.6.2.6 Difference in Technical Efficiency of Fadama III beneficiaries across Individual Crop Farmers

To check for significant difference in the technical efficiency of Fadama III beneficiaries across the economic interest groups, the analysis of variance test was conducted and the result is presented in Table 4.38.

Table 4.38: ANOVA on the Difference in Technical Efficiency across Individual Crop Farmers

Method	Df	Value	Probability
Anova F-test	(3, 376)	17.85423	0.0000
Welch F-test*	(3, 191.098)	16.35255	0.0000

Category Statistics

Variable	Count	Mean	Std.Dev.	Std. Err. of Mean
YAMEFF	120	0.674167	0.237676	0.021697
GNUTEFF	63	0.593030	0.214634	0.027041

RICEEFF	105	0.470476	0.240334	0.023454
CASSAVAEFF	92	0.654971	0.192699	0.020090
All	380	0.599816	0.239096	0.012265

Source: Author's computation using E-views

The result shows the mean efficiency of 0.67, 0.59, 0.47 and 0.65 for yam, groundnut, rice and cassava individual crop farmers respectively. The analysis of variance F-test value of 17.85 with the probability value of 0.00 is statistically significant at 1% level. The Welch F-test is used when the assumption of homogeneity of variance is violated; it shows an F-test value of 16.35 with a probability value of 0.00, meaning that the difference in technical efficiency is significant at 1%. This implies that there is a significant difference in the technical efficiency of Fadama III individual crop farmers' in Benue State.

4.7 Sustainability Status of Fadama III Beneficiaries in Benue State

The sustainability status of Fadama III beneficiaries was analyzed and the results are presented in Tables 4.39 for group and Table 4.40 for individual crop farmers.

Table 4.39: Sustainability indices for Fadama III Economic Interest Groups in Benue State

	ANNIC	FAMSZE	SAV	TEFF	EEFF	NADV	EXADPT	SUST INDEX
LIV	0.52	0.41	0.34	0.59	0.12	0.47	0.51	0.42
AGRO	0.42	0.44	0.31	0.52	0.22	0.47	0.49	0.41
CROP	0.35	0.45	0.32	0.40	0.18	0.38	0.48	0.37

Source: Field Survey, 2015

The results from Table 4.39 shows the sustainability indices of the Economic Interest Groups, the result shows that Livestock (LIV) Economic Interest Group had the highest sustainability index (SUST INDEX) value of 0.42; followed by Agro-processing (AGRO) Economic Interest Group with an index value of 0.41; while Crop (CROP) Economic Interest Group had the lowest index value of 0.37. The indices that that contributed to the high sustainability index for Livestock EIG were annual income (ANNIC), technical efficiency (TEFF) and extent of adoption of technology (EXADPT). For the Crop EIG, the indices that were responsible to the low sustainability index was annual income, technical efficiency and economic efficiency (EEFF).

Table 4.40: Sustainability indices for Fadama III Individual Crop Farmers in Benue State

	ANNY	NFAMY	FAMSZE	SAV	TEFF	EEFF	FAMEXP	NADV	EXADPT	SUST INDEX
YAM	0.42	0.43	0.33	0.23	0.52	0.39	0.40	0.45	0.55	0.42
CAS	0.45	0.14	0.51	0.26	0.61	0.33	0.47	0.42	0.68	0.43
RICE	0.30	0.19	0.42	0.22	0.45	0.30	0.38	0.26	0.65	0.37
GNUT	0.41	0.34	0.56	0.27	0.52	0.22	0.37	0.48	0.57	0.41

Source: Field Survey, 2015

For Fadama III individual crop farmers in Benue State the sustainability indices on Table 4.40 show that cassava (CAS) farmers had the highest sustainability index value of 0.43. On the other hand rice (RICE) farmers had the lowest sustainability index of 0.37. The indicators that contributed to the high sustainability index for cassava farmers were annual income, farm size, technical efficiency and adoption of new technology. On the other hand technical efficiency, non farm income and annual income were the indicators responsible for the low sustainability index for Fadama III rice farmers in Benue State.

It was observed that in both Fadama user groups and individual crop farmers, saving rate and economic efficiency were the indicators with very low indices, the low economic efficiency index implied that beneficiaries were not using their inputs in optimal proportions given their respective prices. This finding agree with Asogwa, Umeh and Okwoche (2012) who reported that allocative inefficiencies were worse than technical inefficiencies among farming households in Benue State.

4.8.1 Factors Limiting Production as perceived by Fadama III Economic Interest Group

The factors limiting production as perceived by Fadama III EIGs were analyzed and presented in Table 4.41

Table: 4.41 Factors Limiting Production as perceived by Fadama III Economic Interest Groups

	Fadama User Group Type							
Limiting factors	**Crop (n=65)**		**Livestock (n=41)**		**Agro-processing (n=35)**		**Fisheries (n=15)**	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Lack of awareness of new technology	23	35.38	21	51.22	9	25.71	3	20
High cost of acquiring new technology	35	53.85	15	36.59	28	80	8	53.33
Inadequate information	42	64.63	12	29.27	11	34.43	2	13.33
Ineffectiveness of new technology	10	15.38	9	21.95	8	22.86	3	20
High cost of inputs	48	73.85	-	-	23	65.71	-	-
High cost of feeds	-	-	37	90.24	-	-	12	80
High mortality rates	-	-	8	19.51	-	-	3	20
Poor roads/transport facilities	25	38.46	14	34.15	12	34.29	7	46.67

Source: Field Survey, 2015

The factors limiting production of Fadama III EIGs presented in Table 4.41 shows high cost of inputs (73.85%) as the main constraints to crop production followed by inadequate information about new technology (64.63%). The least factor inhibiting crop production was ineffectiveness of new technology (15.38%). Livestock EIGs also had high cost of feeds (90.24%) as the main factor inhibiting production, followed by lack of awareness of new technology (51.22%). The least factor inhibiting livestock production was ineffectiveness of new technology (21.95%). Agro-processing EIGs identified high cost of acquiring new technology (80%) as the main factor inhibiting production, followed by high cost of inputs (65.71%), while the least constraining factor was ineffectiveness of new technology (22.86%). Fisheries EIGs identified high cost of feeds (80%) as the main factor inhibiting production followed by high cost of acquiring new technology (53.33%). The least factor inhibiting fish production was inadequate information (13.33%). On the whole the main factors inhibiting production by Fadama III EIGs were high cost of feeds and inputs, while ineffectiveness of technology was the least inhibiting factor to production of economic activities.

4.8.2 Constraints to Rice Production as perceived by Fadama III Rice Farmers in Benue State

Given the low performance of rice production, some constraints were identified as hindrances to increased rice production as perceived by Fadama III rice farmers and presented on Table 4.42.

Table 4.42: Factors Limiting Output as Perceived by Fadama III Rice Farmers

Factors Limiting Output	Fadama III Rice Farmers	
	Frequency	Percentages
High cost of inputs	39	37
Effect of 2012 flood	65	62
Pests and disease	21	20
Poor visit of extension agents	29	28

Source: Field Survey, 2015 Frequency greater than the number is due to multiple responses

The identified constraints shows high cost of inputs, effects of 2012 flood, pests and diseases as well as poor extension services. High cost of inputs and effect of 2012 flood are regarded as major constraints. Sixty two (62) per cent of Fadama III rice farmers identified the effect of flood as a constraint to rice production while thirty seven (37) per cent of Fadama III rice farmers identified high cost of inputs as constraints to rice production. Only Twenty (20) per cent of farmers identified pests and diseases as constraints to rice production.

4.9 Discussion of Findings

In examining the sustainability of Fadama III project in Benue State, the research found that male beneficiaries dominated their female folk and they had more access to all the benefits derived from Fadama III project. This finding agrees with the findings of Ojowu (2011) who stated that improved access of women to Fadama III services is vital to the attainment of poverty reduction since women carry out most of the agricultural activities. Also, Rahman (2013) reported that women have not been given opportunity to realize their full economic potential in agricultural development programmes, as a result of traditional gender-based subordination and disparity between men and women in the size of landholdings and other agricultural resources.

This research also found out that the Fadama III project was not fully implemented in Benue State. One out of three projects in the Fadama User Group's local development plan was executed. This could have been as a result of low contribution of counterpart funds by the State and participating Local Government Areas. This inability to pay up counterpart fund may have contributed to the low performance of the Fadama III project and the non participation of Benue State in the on-going Fadama III project termed Fadama III additional financing which is focused on value addition to crops like cassava and rice closing up in 2019. The services of Fadama III project in terms of providing input and provision of matching grant for onward purchase of input, assets and other services was not timely. This may be the reason for the poor performance of the crop EIG as the indices on annual income, savings and technical efficiency is much less for crop EIG compared to other groups. This is also in consonance with the findings of Ojowu (2011) who asserts that agricultural projects especially farming are time and season specific and late deliveries of advisory services, inputs and extension services could undermine the purpose of the service. Furthermore, timeliness in provision of finance was found to significantly reduce the probability of adopting new technologies in all the Fadama user groups examined thus causing a hindrance to the success of the project.

Finding from the study revealed that Fisheries EIG had the highest average income. This may be attributed to few data spread collected from only fifteen (15) groups. Conversely, it may be as a result of high demand for fish which results to frequency in production and low competition in the industry as the construction of a fish pond and the skills involved in raising fish may be too demanding for others to join the industry. On the other hand, Crop EIG had the lowest average income. This may be that crop farming is usually seasonal, as most farmers undertake one production circle per year whereas, livestock and agro-processor have more production circles which give them the advantage of more income. Also the effect of the 2012 flood may have reduced the output of crop farmers most especially rice farmers who produced along the river banks. This finding is in agreement with the finding of Umeh (2011) who reported that crop production enterprises had the lowest average income and fish production enterprises had the highest average income as a result of rapid turnover. The test of hypothesis (ii) revealed that there is a significant difference in income of Fadama beneficiaries from baseline income. This finding agrees with the findings of Agberavo and Age (2013) who reported that Fadama III participants in Kwande Local Government Area of Benue State unanimously agreed that their participation in Fadama III project has significantly increased their income.

The savings culture of Fadama III beneficiaries in Benue State was generally poor as the average savings (indicator and target for the appraisal of income to be saved annually) was below 10% for more than 70% of the beneficiaries. The reason for poor savings was the absence of Deposit money banks in the local government areas of the beneficiaries and inadequate income from enterprises. Another reason may be the termination of the project in 2013 as farmers were no longer required to tender their bank statements in the hope of getting more funds from the donor agencies. This result is contrary to the findings of Umeh (2011) who reported that at least 20% of beneficiaries across the EIG saved half of their income and the main reason for such saving was given as improvement in credit worthiness and to sustain Sub-Project activities.

Findings of this research show that the factors that positively increase the probability of adopting new technology were output and farm size and the factors that reduce the probability of adopting new technology were savings and timeliness in provision of funds to the Fadama user groups. Uaiane *et al.* (2009) posited that households with access to credit are more likely to adopt new agricultural technologies, which means that for Fadama III beneficiaries, the more saving they make, the more likely they can access credit from financial institutions and the more likely they can increase the adoption of improved technology. For the individual crop farmers, output, formal employment and the number of years spent in an educational institution positively and significantly increased the probability of adopting improved technologies. These findings agree with D'Souza *et al.* (1993), who reported that education was a significant determinant of adoption of sustainable agriculture in West Virginia but that off-farm income did not affect adoption of sustainable agriculture. The findings also agree with Uaiene *et al.* (2009) who reported that households with higher levels of education are also more likely to adopt improved technologies. Furthermore, the number of male beneficiaries significantly reduced the adoption of improved technology by Fadama III individual crop farmers. This finding agree with that of Shimayohol, (2013) who reported that more attention should be given to women, vulnerable groups and the youth to enhance adoption rates by Fadama III beneficiaries in Benue State.

The findings of the study show that Fadama beneficiaries were not efficient in their productive activities. The factors that significantly increase inefficiencies for the Fadama user groups were, savings rate, timeliness in provision of finance and advisory services and those that increase inefficiencies for the individual crop farmers were age and sex . Savings are very important for farmers to access credit from financial institutions, as credit can be used to purchase more inputs and machineries to increase efficiency in production. This is in consonance with the findings of Rahman (2013) who reported that most of the modern inputs are purchased by farmers through cash or on credit, as such, provision of adequate credit facilities will ensure timely and adequate utilization of agricultural inputs for improvement in farm production efficiency. For the variable of advisory services to have increased production inefficiency of Fadama III beneficiaries means that the Fadama III beneficiaries were not getting quality extension services from the service providers to make them efficient in their productive activities. Rahman (2013) reported that agricultural extension not only accelerates the diffusion and adoption of new technologies but also improves the managerial ability of farmers and promotes efficient utilization of existing technologies by improving farmers' knowledge and skills. Therefore, improvement in advisory and extension services will go a long way in reducing inefficiencies in production. Increase in production can reduce the rate of food imports as Nigeria imported US$28bn worth of food between 2008 and 2012 (George, 2015). Given the current fall in oil price, the need to produce efficiently will not only reduce food importation, but also serve as a way of providing food security for Benue State and Nigeria at large.

Finally, the findings of this thesis revealed that Fadama III project in Benue State is possibly not sustainable. This is because the index of sustainability of the beneficiaries in the study; Livestock (0.42), Agro-processing (0.41) and Crop (0.37) EIG, and Rice (0.37), Groundnut (0.41), Yam

(0.42) and Cassava (0.43) for individual farmers fell below 50%. These findings agree with the findings of Ibrahim and Omotessho (2009), who reported that the system of vegetable production under Fadama in the Northern Guinea Savannah Zone of Nigeria was not sustainable and Badiru (2015) who reported that the benefits derived from the Fadama project in Eriti Watershed of Ogun State were not well sustained by the beneficiaries. The findings are also in consonance with the findings of Bakare (2013) who reported that while agriculture remains dominant in the Nigerian economy, it is unsustainable as food supply does not provide adequate nutrients at affordable prices for the average citizen. On the other hand these findings are at variance with the findings of Iwala (2014) who reported that beneficiaries perceived that the Fadama III project was sustainable in Ondo State, and that of Lawal (2010), who found that the production of food crop in the fadama of the Guinea Savanna of Niger State, Nigeria was sustainable.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study was undertaken to evaluate the sustainability of Fadama III project in Benue State. Beneficiaries of the Fadama III project were sampled and grouped into Economic Interest Groups and individual Fadama III farmers. The theories reviewed for the work were the endogenous growth theory, the adoption behaviour model and the stochastic frontier production function. Three Local Government Areas (Logo, Buruku and Otukpo) were purposively selected from the three senatorial zones in Benue State. A total of four Economic Interest Groups, namely, Crop, Livestock, Agro-processing and Fisheries were studied. Furthermore, individual beneficiaries from the Crop EIG were also identified and studied these were those involved in yam, cassava, rice and groundnut production. The questionnaire was used to elicit information from the respondents. The study used descriptive statistics (such as tables, percentages, averages and indices) and inferential statistics (such as the stochastic frontier production function, the logitistic regression analysis, the analysis of variance and the minimum-maximum normalization) to analyze the sustainability of the Fadama III project in Benue State.

Findings of the study revealed that 80.3% of the beneficiaries of the Fadama III project in Benue State were male as against only 19.7% female beneficiaries. The mean age of the respondents was 49.2 years and the average membership size was 23 members. All the Economic Interest Groups accepted that their local development plans were fully approved, but of the three projects approved, only one was implemented and access to grant for the implementation of the projects was not timely. The inability to implement all the projects in the local development plans could be as a result of the failure of Benue State and her participating Local Government to fully pay up their counterpart funds. The Benue State Government paid ₦65,000,000.00 representing 23% of their counterpart fund, participating Local Government paid ₦120,000,000.00 representing 60% of their counterpart fund and International Developing Association (IDA) contributed $6,294,580.72 equivalent to ₦944,187,108 representing 81% of $7,852,529.99 meant for the project.

The average income of Fisheries EIG was the highest while crop EIG had the lowest average income. The t-test revealed that there was a significant difference in the income of Fadama III beneficiaries from the baseline income; also the analysis of variance revealed that there was a significant difference in income of Fadama III EIGs and among the individual crop farmers. Furthermore, the result showed that the average income of the yam individual farmers was the highest while rice farmers had the lowest average income.

Savings of Fadama III beneficiaries in Benue State were not encouraging as the saving rate which was set at 10% of income was not fully complied with. Almost 70% of Fadama user groups did not save up to 10% of their income. The group with the highest savings was agro-processing; while crop EIG had the lowest savings. For the individual crop farmers, 74% of the farmers did not save up to 10% of their income. Yam farmers had the highest savings; while rice farmers had the lowest savings. A number of reasons were given for the inability to save much of their income. These reasons were absence of deposit money banks in some of the local government areas, natural hazards and inadequate income.

Logistic regression analysis was employed to assess the factors affecting the adoption of technology by fadama III beneficiaries. The findings show that timeliness in provision of finance and savings tend to significantly reduce the probability of adopting new technology by the Fadama User Groups.

The technical efficiency of Fadama III beneficiaries were analyzed using the stochastic frontier production function. The findings revealed that there was a significant difference in the technical efficiency of the Fadama III economic interest groups in Benue State. Livestock EIG had the highest technical efficiency while crop EIG had the lowest technical efficiency among the groups. For the individual crop farmers, there was also a significant difference in their technical efficiency. Yam farmers had the highest technical efficiency while rice farmers had the lowest technical efficiency.

On the whole, the sustainability of the Fadama III project in Benue was analyzed, and the result showed that among the three groups analyzed, livestock EIG was more sustainable as annual income, technical efficiency and extent of adoption of technology contributed to its sustainability. On the other hand, crop EIG was less sustainable as annual income, technical efficiency and economic efficiency were responsible for the low sustainability of the group. For the individual crop farmers, groundnut farmers were more sustainable and the indicators that contributed to its sustainability were annual income, farm size, technical efficiency and adoption of technology, while rice farmers were less sustainable as technical efficiency, non farm income and annual income were responsible for their low sustainability.

5.2 Conclusion

The study examined the sustainability of Fadama III project in Benue State. Analysis was made on the various indicators of sustainability. Even though the technical efficiency, income and adoption of technology were high for most of the beneficiaries, their saving and economic efficiency were low for all the beneficiaries. Using the sustainability index which was below 50% for all the beneficiaries, the study concluded that the Fadama III project in Benue State is not sustainable; therefore the main objective of the project which was to sustainably increase the income of the beneficiaries and contribute to poverty reduction was not fully achieved. However, Fadama III was beneficial to most Benue farmers.

5.3 Recommendations

Based on the findings of the research the following recommendations are made:

1. Women should be encouraged to participate in Fadama III cooperatives by giving them a quota that must be filled to reduce inefficiency in production. The contribution of women to agricultural development could be maximized through full integration of women into agricultural and rural development programmes for the purpose of efficiency and sustainability
2. The provision of Deposit Money Bank or Micro-finance Banks in every Local Government Area to encourage saving is paramount to the sustainability of Fadama III in Benue State and Nigeria at large. This can be done if the Central Bank of Nigeria encourages these financial institutions to increase the number of branches in the rural areas and implement branchless banking through the use of direct sales agents and low-cost branchless channels such as Automated Teller Machines (ATM). This will enhance financial inclusion.
3. To improve efficiency in production, the government should regulate the prices of inputs most especially fertilizer and agro-chemicals as most farmers are economically inefficient as a result of high prices of inputs. Also effective extension through advisory services

should be provided to farmers as improved technology may not be adopted unless extension workers provide inputs in terms of the identified and unresolved field problems of farmers.

4. In subsequent agricultural project, provision of finance and inputs should be made on time to encourage farmers most especially crop farmers to start their farm work on time as untimely supply of input and finance has been identified as one of the major setback to bountiful harvest.
5. For similar projects, special incentive should be given to farmers in the event of shocks to help ameliorate the effect of such, as crop (rice) farmers could have done better if they were given special packages like funds and more inputs after the flood to cope with the effect of the flood.
6. Fish production should be encouraged. This can be done by not only teaching farmers' skills in fish farming, but also providing them with fingerlins and fish feed to start their farm. This could lead to increase in income, savings and sustainable development in Benue State.
7. Finally, full implementation of project is paramount to the success of any project. Therefore the government should ensure that projects are fully implemented through the timely and full provisions of her counterpart funds which are a prerequisite for assessing the World Bank's counterpart fund necessary for project implementation.

5.3.1 Suggestions for Further Studies

This study does not claim an exhaustive enquiry in the sustainability of Fadama III project in Benue State. Other researchers may conduct research in related area such as:

1. The Sustainability of Fadama III project in Benue State: An analysis of Fadama Community Associations;
2. The Social Sustainability of Fadama III project in Benue State ; and
3. The Environmental Sustainability of Fadama III project in Benue State.

5.3.2 Limitations of the Study

The limitation of the study is in terms of finance. Due to inadequate finance, the researcher was unable to cover more Local Government Areas so as to access more information on the activities of Fadama III beneficiaries but believes strongly that the area covered is large enough to infer about the whole population. Time was also a limited factor; the time for this research was not long enough to cover all the beneficiaries of Fadama III in Benue State. Furthermore, the researcher who is Tiv by tribe depended on an Idoma speaking assistant to facilitate in Idoma speaking area (Otukpo LGA). The interpreter may not be able to effectively convey the researcher's intensions; however, this limitation may not hinder effective and meaningful research work.

5.3.3 Contribution to Knowledge

This research has made some modest contribution to knowledge in these areas:

1. The study has constructed indices of sustainability of agricultural projects. Project evaluation, particularly, projects for the improvement of productivity is therefore made convenient. Government and funding agencies like the World Bank are therefore armed with a tool with which to measure sustained productivity. This tackles problems of food security, food self sufficiency and therefore, food imports restrictions much more responsively.

2. The study has also provided a means to revamp the rural sector where the challenges of food insecurity and poverty exist. Improvements in productivity, output and incomes are meant to provide succor to farmers and relief to government amidst falling oil prices.
3. Finally, the indices constructed by this study will inform policy makers about the current and subsequent trends in agricultural project performance and encourage public participation in sustainability discussions.

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Appendix I: Questionnaire

SECTION A: SOCIO-ECONOMIC CHARACTERISTICS OF ECONOMIC INTEREST GROUP (EIG) / HOUSEHOLD

1. Name of LGA:……………………………………………………………….

2. Name of FUG/EIG:………………………………………………………………..

3. Group characteristics: a) Men's group [ ] b) Vulnerable group [ ] c) Women's group [ ] d) Both men & women [ ] e) Unemployed youth [ ] f) Others, specify…...........................

4. Vulnerability status: a) Disabled [ ] b) Aged [ ] c) Widow [ ] d) PLWHA [ ] Unemployed youth [ ] e) Others specify………………………………………………..

5. Key enterprise of FUG (*Select only one)*:

   a) Livestock production [ ]
   b) Fisheries production [ ]
   c) Crop farming [ ]
   d) Agro-Processing (palm oil, garri, ground nut, etc.) [ ]
   e) Agro-Forestry [ ]
   f) Marketing [ ]
   g) Others, specify ……………………………………………………………

6. Membership size ………………………………………………………………….

7. Age of household head (years):………………………………………………………..

8. Household size:………………………

9. Sex of household head: a) Male [ ] b) Female [ ]

10. Level of education: a) Primary [ ] b) Secondary [ ] c) ND/NCE [ ] d) HND/Degree [ ] e) Masters [ ] f) Non-formal education [ ]

11. Number of years spent in a formal educational institution:………………………………

12. What is your primary occupation?..

13. How long have you been farming/Business?...

14. Please state your position in the FUG

a) Chairman [ ] b) Secretary [ ] c) Treasurer [ ] d) Financial secretary [ ]

e) Member [ ] f) Others, specify……………………………

15. Which off-farm activity are you *mainly* engaged in?

a) Trading [ ] b) Civil service [ ] c) Food vending [ ] d) Running a business centre [ ]

e) Saloon business [ ] f) Others, specify…………………………

16. Please, state the *annual income* you realize from the off-farm activity indicated above ₦………………………………

SECTION B: ADOPTION OF TECHNOLOGY BY EIG/HOUSEHOLD

1. Please tick where appropriate the technologies introduced by NFDP III and the ones adopted by your firm/household.

A). Crop technologies for crop EIG

Improved crop technology	**Technology Introduced by NFDP III (Tick √)**	**Technology adopted by beneficiary (Tick √)**	**Has there been a change from what you did before Fadama III? Yes=1 No=0**	**What are the major constraints[1] to adoption of this improved technology?**
Use of improved varieties of crop				
Inorganic Fertilizer application				
Use of organic fertilizer(manure)				

Correct spacing				
Use of herbicide				
Record keeping				
Irrigation Farming				
Soil conservation				
Pest control				
Staking				
Others, specify				

[1]Constraints

a) Lack of awareness of technology [ ]

b) High cost of acquisition [ ]

c) Inadequate information on proper usage [ ]

d) Ineffectiveness of technology [ ]

e) Others, specify……………………………………

B). Livestock technologies for livestock EIG

Improved Livestock Technology	**Technology Introduced by NFDP III** **(Tick √)**	**Technology adopted by beneficiary** **(Tick √)**	**Has there been a change from what you did before Fadama III? Yes=1** **No=0**	**What are the major constraints[1] to adoption of this improved technology?**
Use of hybrid livestock				
Vaccination				
Culling				

Use of veterinary services				
Use of improved feeds				
Use of salt lich for livestock				
Record keeping				
Quarantine				
Grass Cutter breeding				
Silage and Hay making				
Others, specify				

[1]Constraints

a) Lack of high breed of animals [ ]

b) Inadequate knowledge of new technology [ ]

c) High mortality rate [ ]

d) Lack of veterinary services [ ]

e) High cost involved [ ]

f) Others, specify……………………………………

C). Fisheries technologies for fisheries EIG

Improved Fishery Technology	**Technology Introduced by NFDP III (Tick √)**	**Technology adopted by beneficiary (Tick √)**	**Has there been a change from what you did before Fadama III? Yes=1 No=0**	**What are the major constraints[1] to adoption of this improved technology?**
Feed formulation				
Improved method of				

feeding				
Improved method of harvesting				
Use of improved fingerlings				
Use of concrete pond				
Improved method of sorting				
Improved method of treatment				
Record keeping				
Hatchery and fingerling production				
Restocking of exploited water				
Regulated net mesh size				
Others, specify				

[1]Constraints

a) Lack of fingerlings [ ]

b) Inadequate knowledge of the technology [ ]

c) Low demand for fish [ ]

d) Scarcity of water in dry season [ ]

e) High cost involved [ ]

f) Others, specify……………………………………

D). Agro-processing technologies for agro-processing EIG

Improved agro-processing technology	**Technology Introduced by NFDP III** **(Tick √)**	**Technology adopted by beneficiary** **(Tick √)**	**Has there been a change from what you did before Fadama III? Yes=1** **No=0**	**What are the major constraints[1] to adoption of improved agro-processing technology?**
Fish processing				
Garri processing				
Cassava flour processing				
Soya bean processing				
Palm oil processing				
Groundnut shelling				
Rice processing				
Business planning				
Record keeping				
Proper storage of inputs/products				
Hygienic drying method				
Improved quality of product				
Machine maintenance				

skills				
Others, specify				

[1]Constraints

a) Inefficient processing machines [ ]

b) High cost of maintenance of machines [ ]

c) High cost of fuel/diesel/oil [ ]

d) Lack of storage facilities [ ]

e) Others, specify……………………………………

SECTION C: RESOURCE USE EFFICIENCY OF PRODUCTIVE ASSET OF ECONOMIC INTEREST GROUPS/ HOUSEHOLD

1. Please state the type of asset owned by your FUG:………………………………………

2. What is your farm size? ………………………….. (*Kindly underline the appropriate option*) (ha)/ stands/ herds/ fishes/birds others,specify…………………………………..

3. What is your annual output? ---(unit)

4. What is your annual total cost of production?₦………………………………

5. Please, state the *annual income* realized from the economic activity indicated above ₦……………………………………

6. State the total estimated number of days worked by your family members /hired labour during the last season on the farm/enterprise in the table below:

Labour	Number of Days	No. of Adult male	No. of Adult female	No. of Children
Family labour				
Hired labour				

7.What is your annual total cost of hired labour during the last season?
₦……………………………

8. Please report the types (eg. seeds, seedlings, fertilizer, agrochemicals, bags of feeds, litres of fuel fingerlings etc.) and sources of agricultural inputs and their accessibility since you joined FUG

Input	1.Quantity (Unit)	2. Major source of input[1]	3. cost of input	4. Source of funds for buying input[2]	5. Perception on accessibility[3]	6. Perception on timeliness of availability[4]	7. Perception on quality[5] of input	8. Did the quantity bought satisfy your needs? Yes = 1, No = 2	9. If no, why not?[6] Give at most three reasons		
									1	2	3

[1] **Source of input**: 1 = Input traders, 2 = ADP, 3 = Fadama III, 4 = NGO or project other than Fadama III, 5 = Other farmers, 6 = Farmer association/group, 7= open market, 8= self (from past harvest), 99 = Others (specify)

[2] **Source of funds**: 1 = Bank, 2 = NGO, 3 = Micro finance institution, 4 = Input trader, 5 = Fadama III , 6 = Relatives/friends, 7 = Farmer group/association 8 = Cooperative 9= own funds, 10=other farmers 99 = Others (specify)

[3] **Accessibility**: 1 = Highly accessible, 2 = Accessible, 3 = poor accessibility 4 = Not accessible

[4] **Timeliness**: 1 = Timely 2 = Untimely

[5] **Quality of input**: 1 = High quality 2 = Average quality 3 = Poor quality 4 = Very poor quality

[6] **Why not satisfy needs**: 1 = Too expensive 2 = Not available on time 3 = Quantity sold not enough 4 = Too high transportation costs 5 = Poor roads or lack of transportation equipment/vehicles 7 Others (specify)………………………………………………..

SECTION D: INCOME AND SAVING CULTURE OF EIG/HOUSEHOLD

1. How much income does your FUG make annually? ₦..

2. How much money does your FUG save annually?₦……………………………

3. How much money do you save as an *individual/household* annually? ₦………………

4. Does your FUG collect user-fee from non-members of your group who benefit from your subproject?

i) It collects [ ] ii) It does not collect [ ] iii) Not applicable [ ]

5. If it collects, how much does the FUG collect as user-fee? ₦…………………………

6. How much of the user-fee does your FUG save? ₦…………………………

7. Where does your FUG keep its savings?

i) FUG's account (FUEF) [ ] ii)With the Exco [ ] iii)FUG does not save user-fee [ ]

8. Which of these factors limit your savings?

i) Inadequate income from enterprise [ ]
ii) Size of responsibilities outstrip income [ ]
iii) Not literate enough to save in the banks [ ]
iv) No nearby savings bank [ ]
v) Others, please specify………………………………

9. Please state the project embarked upon and the cost/contribution involved in the table below:

Project:………………………………………………………………………………………

Source of contribution (₦)	Year				
	2009	2010	2011	2012	2013
FUG Members					
Donor Agencies					
Total contributed					
Total cost of project					
Amount spent so far on project					

SECTION E: IMPLEMENTATION OF PROJECT ACROSS THE COMPONENTS

a) Component One: Capacity Building Communication and Information Support

1. Were you part of the selection of the enterprise/project of your EIG?: i) I was part of the selection [ ] ii) I was not [ ]
2. Did you participate in the planning of the activities of your EIG? i) I participated [ ] ii) I did not participate [ ]
3. Did you participate in deriving the LDP? i) I participated [ ] ii) I did not participate [ ]

4. How many projects has the EIG funded?..

5. How many projects has the EIG completed?...

b) Component Two: Small-scale Community Owned Infrastructure

1. How many rural infrastructure are completed in your community?.................................

2. How many are under construction/ rehabilitation?...

3. What are the various types of rural infrastructure provided in the community by Fadama?

i) Road [ ] ii) Culvert [ ] iii Bridge [ ] iv) Markets [ ] v) Borehole [ ]
vi) Recreational facility [ ] vii) Others, specify.............................

C) Component Three: Advisory Services and Input Surport

1. What are the sources of your advice or information? i) ADP [ ] ii) NGO affiliated with Fadama III [ ] iv) Radio [ ] v) TV [ ] vi)Mobile Phone services [ ] vii) Farmers [ ] viii) Print Media [ ]

2. How many times have you received advisory services or information from service provider since joining FUG ?......................................

3. Did you ask for these advisory services or information? i) yes [ ] ii) No [ ]

4. Did you pay for these advisory services or information? i) yes [ ] ii) No [ ]

d). Component 4: Asset Acquisition and Market Systems Development

1. What are the major agricultural commodities produced by your FUGs?

i) Soybean [ ] ii) yam [ ] iii cassava [ ] iv rice [ ] v maize [ ] vi sorghum [ ]

vii millet [ ] viii groundnut [ ] ix cowpea [ ] x others specify.......................

2. What are the processing activities carried out by your FUGs for each commodity named in (1) above?

i) ....
ii) ....
iii) ....

3.How much was a unit of processed commodity (named in 2) sold before Fadama III?

(i) ....
(ii) ....
(iii) ....

4. How much is the same unit of commodity sold now?
   (i) ....
   (ii) ....
   (iii) ....
5. What was your average income from the sale of this commodity when it was not processed (in Naira/annum)?...

6. What is your average income from the sale of the same quantity of commodity after processing (in Naira/annum)?...

7. Please list the markets available to your community?

i. ....
ii. ....
iii. ....

8. Do you have access to these markets at all seasons? i) yes [ ] ii) No [ ]

9. How long do you or members of your community wait for vehicle before Fadama III?

i) 5 minutes [ ] ii) 10 minutes [ ] iii) 15 minutes [ ] iv) 20 minutes [ ]
others, specify..

10. How long do you or members of your community wait for vehicle now?
   i) 5 minutes [ ] ii) 10 minutes [ ] iii) 15 minutes [ ] iv) 20 minutes [ ]
   Others, specify...

e). Component 5: Support to ADPs and Adaptive Research

1. Have you or any member of this household participated in any agricultural research or extension demonstration plot or other research activities since joining FUG? i) Yes [ ] ii No [ ]

2. If yes, tick the provider of the research or extension services i) ADP [ ] ii) NGO affiliated with Fadama III [ ] iii) Private extension/research providers [ ] iv) Farmers to Farmers [ ] Others, specify………………………………………..

3. How many times have you or any member of your household participated in any agricultural research or extension services? …………………………………

Appendix II: Result Monitoring Framework (Implementation Guide)

Result Monitoring Framework (Implementation Guide)

			TARGET VALUES				
INTERMEDIATE OUTCOME	INDICATORS	BASELINE	YR 1	YR 2	YR 3	YR 4	YR 5
Component 1: capacity building communications and information support (CBCI) 1. Increased participation of Fadama users in the management of Fadama resources.	1:By mid term review,75% of participating communities have local development plans (LDPs) develop through a participatory process.	0	30 %	65 %	75 %	75 %	75 %
2. strengthened capacity of FUGs and FCAs in managing development projects	2. By end of project 75% of FCAs have fully (100%) implemented approved LDPs.	0	0% 10 %	0% 25 %	5% 60 %	15 % 70 %	20 % 75 %
3. Strengthened capacity of participating local government authorities (LGAs) for participatory planning	3. By end of project, (20%) of participating local government authorities integrate local development plans into their annual plans.	0	0	0%	5%	15 %	20 %
Component 2: small – scale community – owned infrastructure (SCI) 1. Improved access of communities to productive rural infrastructure that generates shared economic or	1. 40% of participating Fadama communities have at least one productive rural infrastructure constructed/rehabilitated(disaggregated by feeder roads, culverts/small bridges)	0	0%	5%	15 %	30 %	40 %

environmental benefits							
Component 3: Advisory services and input support (ASIS) 1.increased utilization of rural advisory services	1. 30% increase in the number of Fadama users procuring rural advisory services in the participating communities (disaggregated by gender and vulnerable groups).	45.3%	5%	10 %	20 %	25 %	30 %
2. Increased access to agricultural inputs.	2. 50% increase in the number of Fadama farmers with to agricultural inputs (disaggregated by gender and vulnerable groups): Improved Seed Organic Manure Agro- chemicals	 24.25% 14.31% 30%	10 %	20 %	30 %	40 %	50 %
Component 4: support to ADPs and adaptive research 1. Strengthened capacity of ADPs to provide extension services to Fadama farmers. 2. strengthened link between Fadama users and	1. 30% increase in the number of Fadama farmers receiving extension services from ADPs (disaggregated by gender and vulnerable groups) 2. 20% increase in new technology adopted in Fadama Communities (disaggregated by technology, gender, vulnerable groups, age and farm size):	49.50%	5%	10 %	20 %	25 %	30 %

research institutions							
Component 5: Asset Acquisition and market system development 1. Increased value added to agricultural products	1. 20% increase in income from sales of value added agricultural product Crops Fisheries Livestock	 69.4% 7.75% 2.72%	0	5%	10 %	15 %	20 %
2.	3. 30% of FCAs have access to market information	0	5%	10 %	20 %	25 %	30 %

Source: World Bank (2008)

Appendix III: Economic Interest Groups across LGA's in Benue State

S/No	LGA	Zone	Economic Interest Groups (EIGs)						
			Crop	Livestock	Agro Processing	Marketing	Fisheries	Agro Forestry	Total
1	KATSINA ALA	A	32	15	8	3	3	0	61
2	KONSHISHA	A	49	12	9	0	4	0	74
3	USHONGO	A	50	29	19	9	3	4	114
4	LOGO	A	62	35	11	8	5	0	121
5	UKUM	A	80	15	5	5	2	0	107
6	V/KYA	A	40	60	20	0	9	0	129
7	KWANDE	A	36	34	3	0	2	1	76
	Sub-total(A)		**349**	**200**	**75**	**25**	**28**	**5**	**682**
8	BURUKU	B	66	19	11	0	5	2	103
9	GWER EAST	B	56	10	9	0	0	0	75
10	GWER WEST	B	18	4	2	0	1	0	25
11	GBOKO	B	30	7	12	2	2	0	53
12	TARKA	B	37	15	18	2	8	0	80
13	GUMA	B	27	5	19	4	0	0	55
14	MAKURDI	B	52	19	22	4	2	0	99
	Sub-total(B)		**286**	**79**	**93**	**12**	**18**	**2**	**490**
15	APA	C	55	29	12	0	0	0	96
16	OGBADIBO	C	35	17	62	3	0	0	117
17	OTUKPO	C	90	27	13	2	5	0	137
18	AGATU	C	39	4	11	1	5	0	60
19	OKPOKWU	C	70	23	39	2	3	0	137
20	OJU	C	100	25	13	0	0	0	138
	Sub-total(C)		**389**	**125**	**150**	**8**	**13**	**0**	**685**
TOTAL			**1024**	**404**	**318**	**45**	**59**	**7**	**1857**

Source: Benue State Fadama Coordinating Office (2013a)

Appendix: IV International Development Association (IDA) Draw-down Schedule

International Development Association (IDA) Draw-down Schedule

S/N	Borrower Reference	Amount (USD)	Value Date
1	BN/SFCO-001	600,000.00	12-Aug-2009
2	BN/SFCO-002	167,362.93	19-Nov-2009
3	BN/SFCO-003	148,158.17	04-Mar-2010
4	BN/SFCO-004	61,112.29	01-Apr-2010
5	BN/SFCO-005	161,484.48	04-May-2010
6	BN/SFCO-006	362,442.07	21- May-2010
7	BN/SFCO-007	72,966.64	07-Jul-2010
8	BN/SFCO-008	27,769.52	27-Jul-2010
9	BN/SFCO-009	55,086.08	27-Aug-2010
10	BN/SFCO-010	26,231.58	22-Sep-2010
11	BN/SFCO-011	333,302.01	21-Oct-2010
12	BN/SFCO-012	62,960.68	30-Dec-2010
13	BN/SFCO-013	83,710.59	07-Jan-2011
14	BN/SFCO-014	114,038.19	20-Jan-2011
15	BN/SFCO-016	147,632.21	18-Feb-2011
16	BN/SFCO-017	72,288.00	25-Mar-2011
17	BN/SFCO-019	396,191.85	15-Apr-2011
18	BN/SFCO-021	118,823.74	17-May-2011
19	BN/SFCO-022	73,066.86	05-Jul-2011
20	BN/SFCO-023	71,845.32	25-Jul-2011
21	BN/SFCO-024	177,571.85	29-Aug-2011
22	BN/SFCO-025	134,428.51	28-Sep-2011
23	BN/SFCO-026	139,356.51	15-Nov-2011
24	BN/SFCO-028	59,302.61	22-Nov-2011
25	BN/SFCO-029	216,474.58	28-Dec-2011
26	BN/SFCO-030	38,157.95	16-Feb-2012
27	BN/SFCO-031	97,484.61	05-Mar-2012
28	BN/SFCO-032	40,565.80	30-Mar-2012
29	BN/SFCO-033	89,922.74	09-May-2012
30	BN/SFCO-034	43,771.26	14-Jun-2012
31	BN/SFCO-035	78,269.72	25-Jun-2012
32	BN/SFCO-036	72,715.73	06-Aug-2012
33	BN/SFCO-037	124,332.00	04-Sep-2012
34	BN/SFCO-038	29,412.78	27-Sep-2012
35	BN/SFCO-039	66,337.81	29-Nov-2012
36	BN/SFCO-040	157,482.28	28-Jan-2013
37	BN/SFCO-041	104,215.30	03-Apr-2013
38	BN/SFCO-042	141,346.51	21-May-2013
39	BN/SFCO-043	388,738.48	20-Jun-2013
40	BN/SFCO-044	130,029.47	19-Jul-2013
41	BN/SFCO-045	402,647.26	13-Aug-2013
42	BN/SFCO-046	226,982.88	24-Sep-2013
43	BN/SFCO-047	178,560.87	09-Oct-2013
	Total Drawdown	6,294,580.72	
	Total Outstanding	1,557,949.27	
	Percentage Drawdown	81%	
	Total Allocation	7,852,529.99	

Source: Fadama III State Coordinating Office (2013b)

Appendix V A: ANOVA on Difference in Income across Economic Interest Groups

Test for Equality of Means Between Series
Date: 12/31/15 Time: 12:29
Sample: 1 65
Included observations: 65

Method	df	Value	Probability
Anova F-test	(3, 152)	26.49399	0.0000
Welch F-test*	(3, 50.3331)	25.81661	0.0000

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	3	4.04E+12	1.35E+12
Within	152	7.73E+12	5.09E+10
Total	155	1.18E+13	7.59E+10

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
AGROANNINC	35	501657.1	221613.6	37459.53
CROPANNINC	65	362184.6	181234.7	22479.40
LIVANNINC	41	579161.0	286300.4	44712.61
FISHANNINC	15	722941.5	220164.2	56846.14
All	156	541486.1	275575.8	22063.72

Appendix V B: ANOVA on Difference in Income across Individual Crop Farmers

Test for Equality of Means Between Series
Date: 01/20/16 Time: 21:38
Sample: 1 120
Included observations: 120

Method	df	Value	Probability
Anova F-test	(3, 376)	3.765365	0.0110
Welch F-test*	(3, 205.387)	7.382290	0.0001

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	3	1.93E+11	6.43E+10
Within	376	6.42E+12	1.71E+10
Total	379	6.61E+12	1.74E+10

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
YAMANNINC	120	250216.7	139251.6	12711.87
CASANNINC	92	248304.3	147270.5	15354.01
RICEANNINC	105	189388.9	134304.6	13106.79
GNUTANNINC	63	220314.3	65105.09	8202.471
All	380	231406.6	132090.8	6776.116

Appendix V C: ANOVA on Difference in Technical Efficiency across Economic Interest Groups

Test for Equality of Means Between Series
Date: 01/15/16 Time: 18:31
Sample: 1 66
Included observations: 66

Method	df	Value	Probability
Anova F-test	(2, 138)	75.95923	0.0000
Welch F-test*	(2, 91.0897)	69.12145	0.0000

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	2	6.615008	3.307504
Within	138	6.008954	0.043543
Total	140	12.62396	0.090171

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
AGROEFF	35	0.809714	0.116908	0.019761
LIVEFF	41	0.868537	0.124209	0.019398
CROPEFF	65	0.409077	0.277465	0.034415
All	141	0.642128	0.300285	0.025289

Appendix V D: ANOVA on Difference in Difference in Technical Efficiency across Individual Crop Farmers

Test for Equality of Means Between Series
Date: 01/03/16 Time: 11:17
Sample: 1 120
Included observations: 120

Method	df	Value	Probability
Anova F-test	(3, 376)	17.85423	0.0000
Welch F-test*	(3, 191.098)	16.35255	0.0000

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	3	2.701595	0.900532
Within	376	18.96469	0.050438
Total	379	21.66629	0.057167

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
YAMEFF	120	0.674167	0.237676	0.021697
GNUTEFF	63	0.593333	0.214634	0.027041
RICEEFF	105	0.470476	0.240334	0.023454
CASSAVAEFF	92	0.654891	0.192699	0.020090
All	380	0.599816	0.239096	0.012265

Appendix V E: Variance Inflator Factor of Firewood and Petrol

Appendix VI A: Logit Regression Result for Crop EIG

Dependent Variable: EXTADOPCROP
Method: ML - Binary Logit (Quadratic hill climbing)
Date: 11/12/15 Time: 06:28
Sample: 1 65
Included observations: 65
Convergence achieved after 7 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
SAR	-2.177918	0.482274	-4.515934	0.0017
OKG	1.003547	0.301285	3.330889	0.0058
PRI	0.875806	0.352630	2.483640	0.0173
ACM	0.105062	0.091704	1.145664	0.3288
ADS	-0.021460	0.062934	-0.340992	0.7524
TMF	-3.193158	0.955443	-3.342070	0.0025
FMS	0.856241	0.300958	2.845051	0.0109
CTF	-0.020120	0.041051	-0.490122	0.6325
CTA	0.041012	0.573101	0.071561	0.9319
CTSS	-0.877612	0.357029	-2.458095	0.0187
C	-3.770288	1.555624	-2.423650	0.0209

McFadden R-squared	0.457856	Mean dependent var	0.738462
S.D. dependent var	0.442893	S.E. of regression	0.350113
Akaike info criterion	1.023097	Sum squared resid	6.374096
Schwarz criterion	1.457974	Log likelihood	-20.25065
Hannan-Quinn criter.	1.194684	Deviance	40.50129
Restr. deviance	74.70579	Restr. log likelihood	-37.35290
LR statistic	34.20450	Avg. log likelihood	-0.311548
Prob(LR statistic)	0.000626		

Obs with Dep=0	48	Total obs	65
Obs with Dep=1	17		

Appendix VI B: Logit Regression Result for Agro-processing EIG

Dependent Variable: EXTADOPAGRO
Method: ML - Binary Logit (Quadratic hill climbing)
Date: 11/21/15 Time: 09:36
Sample: 1 35
Included observations: 35
Convergence achieved after 6 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
CTFW	0.470686	0.189840	2.479383	0.024686
SAR	-1.639096	0.919624	-1.782355	0.639096
OKG	0.900036	0.300152	2.998601	0.012036
ADS	0.230896	0.172077	1.341818	0.230896
CTP	-0.150140	0.420255	-0.357259	0.710140
ACM	0.171659	0.907682	0.189118	0.171659
TMF	-1.149147	0.449688	-2.555432	0.023147
C	0.823341	2.982101	0.276094	0.823341

McFadden R-squared	0.477037	Mean dependent var	0.485714
S.D. dependent var	0.507093	S.E. of regression	0.534498
Akaike info criterion	1.768768	Sum squared resid	6.856508
Schwarz criterion	2.257592	Log likelihood	-19.95344
Hannan-Quinn criter.	1.937510	Deviance	39.90688
Restr. deviance	48.49173	Restr. log likelihood	-24.24586
LR statistic	15.54846	Avg. log likelihood	-0.570098
Prob(LR statistic)	0.031903		

Obs with Dep=0	10	Total obs	35
Obs with Dep=1	25		

Appendix VI C: Logit Regression Result for Livestock EIG

Dependent Variable: EXTADOPLIV
Method: ML - Binary Logit (Quadratic hill climbing)
Date: 11/21/15 Time: 09:42
Sample: 1 41
Included observations: 41
Convergence achieved after 8 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
HDS	0.205730	0.084884	2.423661	0.0247
OKG	0.600027	0.270067	2.221771	0.0296
ADS	0.014097	0.078364	0.179891	0.8572
CTFD	-0.563002	0.204042	-2.759248	0.0243
ACM	0.794155	0.485056	1.637244	0.3117
TMF	-0.272308	0.082008	-3.320505	0.0207
SAR	-0.685037	0.289411	-2.367004	0.0280
C	0.563885	1.761398	0.320135	0.7489

McFadden R-squared	0.374616	Mean dependent var	0.731707
S.D. dependent var	0.448575	S.E. of regression	0.472952
Akaike info criterion	1.466564	Sum squared resid	7.381567
Schwarz criterion	1.800919	Log likelihood	-22.06456
Hannan-Quinn criter.	1.588318	Deviance	44.12912
Restr. deviance	47.68737	Restr. log likelihood	-23.84369
LR statistic	23.58251	Avg. log likelihood	-0.538160
Prob(LR statistic)	0.000018		

Obs with Dep=0	11	Total obs	41
Obs with Dep=1	30		

Appendix VI D: Logit Regression Result for Cassava Individual Crop Farmers

Dependent Variable: EXTADOPCASSAVA
Method: ML - Binary Logit (Quadratic hill climbing)
Date: 01/03/16 Time: 11:29
Sample: 1 92
Included observations: 92
Convergence achieved after 6 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FMS	0.215820	0.360648	0.598424	0.5496
FEMP	0.925908	0.533621	1.735141	0.0827
ADS	0.124570	0.069124	1.802134	0.0715
CTA	5.63E-05	9.93E-05	0.566758	0.5709
CTF	-5.80E-05	4.84E-05	-1.198570	0.2307
CTSL	-0.030241	0.012636	-2.393200	0.0167
AGE	-0.018419	0.028520	-0.645836	0.5184
SEX	-0.091343	0.028137	-3.246310	0.0025
EDU	0.029709	0.050381	0.589694	0.5554
OKG	5.51E-05	0.000270	0.204490	0.8380
C	0.348673	2.390572	0.145853	0.8840

McFadden R-squared	0.161669	Mean dependent var	0.684783
S.D. dependent var	0.467148	S.E. of regression	0.450305
Akaike info criterion	1.284046	Sum squared resid	16.42475
Schwarz criterion	1.585564	Log likelihood	-48.06612
Hannan-Quinn criter.	1.405741	Deviance	96.13223
Restr. deviance	114.6710	Restr. log likelihood	-57.33548
LR statistic	18.53873	Avg. log likelihood	-0.522458
Prob(LR statistic)	0.046528		
Obs with Dep=0	29	Total obs	92
Obs with Dep=1	63		

Appendix VI E: Logit Regression Result for Yam Individual Crop Farmers

Dependent Variable: EXTADOPYAM
Method: ML - Binary Logit (Quadratic hill climbing)
Date: 11/21/15 Time: 14:36
Sample: 1 120
Included observations: 120
Convergence achieved after 6 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FMS	0.847123	0.308020	2.750221	0.0260
OKG	0.231236	0.080057	2.888401	0.0244
ADS	-0.024683	0.079019	-0.312368	0.7548
AGE	0.009769	0.018522	0.527427	0.5979
SEX	-1.771483	0.486840	-3.638738	0.0200
LEDU	0.174136	0.065907	2.642150	0.0283
CTF	-0.652009	0.231220	-2.819864	0.0254
CTA	-0.573030	0.224058	-2.557510	0.0218
FEMP	0.773397	0.458850	1.685512	0.0919
ACM	0.056580	0.172963	0.327121	0.7346
CTSL	-0.435271	0.108662	-0.249643	0.8024
C	4.152102	2.554821	1.625203	0.1041

McFadden R-squared	0.413569	Mean dependent var	0.550000
S.D. dependent var	0.499580	S.E. of regression	0.487866
Akaike info criterion	1.436641	Sum squared resid	25.46745
Schwarz criterion	1.738620	Log likelihood	-73.19848
Hannan-Quinn criter.	1.559276	Deviance	146.3970
Restr. deviance	165.1533	Restr. log likelihood	-82.57666
LR statistic	18.75636	Avg. log likelihood	-0.609987
Prob(LR statistic)	0.014580		

Obs with Dep=0	54	Total obs	120
Obs with Dep=1	66		

Appendix VI F: Logit Regression Result for Rice Individual Crop Farmers

Dependent Variable: EXTADOPRICE
Method: ML - Binary Logit (Quadratic hill climbing)
Date: 11/21/15 Time: 14:39
Sample: 1 105
Included observations: 105
Convergence achieved after 6 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FMS	1.202362	0.371884	3.233164	0.0213
OKG	-0.210185	0.184054	-1.141975	0.2516
ADS	-0.111370	0.050851	-2.190124	0.0231
AGE	-0.041115	0.026149	-1.572335	0.1159
SEX	-0.139142	0.611113	-0.227686	0.8199
LEDU	1.075464	0.341731	3.147107	0.0204
CTF	0.032016	0.030623	1.045489	0.2956
CTA	-0.478040	0.105045	-4.550800	0.0019
FEMP	0.225816	0.467959	0.482555	0.6294
ACM	-0.518351	0.411076	-1.260961	0.9689
CTS	-0.730002	0.210015	-3.475955	0.0215
C	2.929376	1.838025	1.593763	0.1110

McFadden R-squared	0.442577	Mean dependent var	0.647619
S.D. dependent var	0.480003	S.E. of regression	0.488630
Akaike info criterion	1.451244	Sum squared resid	21.96586
Schwarz criterion	1.779829	Log likelihood	-63.19029
Hannan-Quinn criter.	1.584393	Deviance	126.3806
Restr. deviance	136.2707	Restr. log likelihood	-68.13535
LR statistic	9.890128	Avg. log likelihood	-0.601812
Prob(LR statistic)	0.625599		

Obs with Dep=0	37	Total obs	105
Obs with Dep=1	68		

Appendix VI G: Logit Regression Result for Groundnut Individual Crop Farmers

Dependent Variable: EXTADOPGNUT
Method: ML - Binary Logit (Quadratic hill climbing)
Date: 01/03/16 Time: 11:42
Sample: 1 63
Included observations: 63
Convergence achieved after 11 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FMS	4.69E-06	3.07E-06	1.525392	0.1272
OKG	2.356545	0.895523	2.631473	0.0085
ADS	0.408229	1.076022	0.379387	0.7044
AGE	-1.514168	1.132738	-1.336733	0.1813
SEX	-1.330024	1.060503	-1.254144	0.2098
LEDU	0.090051	1.152572	0.078130	0.9377
CTF	-0.321163	1.037162	-0.309656	0.7568
CTA	-0.431059	0.154563	-2.788885	0.0053
FEMP	3.146434	1.239830	2.537795	0.0112
ACM	0.770936	0.548119	1.406512	0.1596
CTS	-6.26E-07	3.47E-05	-0.018062	0.9856
C	5.250678	3.575666	1.468448	0.1420

McFadden R-squared	0.408561	Mean dependent var	0.746032
S.D. dependent var	0.438776	S.E. of regression	0.366666
Akaike info criterion	1.082980	Sum squared resid	6.722184
Schwarz criterion	1.525214	Log likelihood	-21.11387
Hannan-Quinn criter.	1.256913	Deviance	42.22775
Restr. deviance	71.39826	Restr. log likelihood	-35.69913
LR statistic	29.17051	Avg. log likelihood	-0.335141
Prob(LR statistic)	0.003717		

Obs with Dep=0	16	Total obs	63
Obs with Dep=1	47		